

FINAL

Smoky Canyon Mine Remedial Investigation/Feasibility Study

Phase 2 Pilot Study Work Plan and Sampling and Analysis Plan

**Ultra-Filtration/Reverse Osmosis and Biological Selenium
Removal Fluidized Bed Bioreactor Treatment Technology**

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- A Selenium Concentration and Flow Data for South Fork Sage Creek Springs and Hoopes Spring
- B Pilot Study Work Plan and Sampling and Analysis Plan, (Phase 1) Biological Selenium Removal Treatment Technology, Fluidized Bed Bioreactor (September 5, 2014 Final submittal, along with updates and addenda)
- C Monthly Progress Reports for Phase 1 FBR Treatability Study
- D Summary of Results Phase 1 Biological Selenium Removal Treatment Technology, Fluidized Bed Bioreactor
- E Smoky Canyon Mine Quality Assurance Project Plan for Environmental Monitoring Activities (Appendix B of the Comprehensive Environmental Monitoring Program Plan [CEMPP], Draft Revision No. 4)
- F Laboratory Certifications for Environmental Work

LIST OF ACRONYMS

AOC	Administrative Order on Consent
BOD	Biochemical Oxygen Demand
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIP	clean in place
CMP	corrugated metal pipe
COC	Chain of Custody
COD	Chemical Oxygen Demand
COPC	Chemical of Potential Concern
DO	dissolved oxygen
DQIs	Data Quality Indicators
DQOs	Data Quality Objectives
EDD	electronic data deliverable
FBR	Fluidized Bed Bioreactor
F/M	food to microorganism ratio
FS	Feasibility Study
gpd	gallons per day

gpm	gallons per minute
H ₂ S	Hydrogen Sulfide
HASP	Health and Safety Plan
HDPE	high-density polyethylene
IDEQ	Idaho Department of Environmental Quality
IDW	Investigation-Derived Waste
mg/L	milligrams per liter
MSHA	Mine Safety and Health Administration
N	nitrogen
ODA	overburden disposal area
O&M	Operation and Maintenance
ORP	Oxidation-Reduction Potential
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAS	Return Activated Sludge
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RO	Reverse Osmosis
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SRT	sludge retention time
TCLP	Toxicity Characteristic Leaching Procedure
TSS	Total Suspended Solids
UF	Ultra-Filtration
µg/L	micrograms per liter
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
WAS	Waste Activated Sludge
ZVI	Zero-Valent Iron

Acknowledgement

Information on the pilot system, including figures and tables were taken directly from reports prepared by Frontier Water Systems, Salt Lake City, Utah. Information presented in the design tables has been taken from drawings prepared by Stantec. Additional information and drawings have been provided by J4 Engineering Group, Boise, Idaho.

1.0 INTRODUCTION

The J.R. Simplot Company (Simplot) owns and operates the Smoky Canyon phosphate mine in southeastern Idaho (Figure 1-1). The Smoky Canyon Mine (“Mine” or “Site”) is the subject of a 2009 Administrative Order on Consent (AOC) entered into by the U.S. Forest Service (USFS), U.S. Environmental Protection Agency (USEPA), Idaho Department of Environmental Quality (IDEQ), and Simplot. The AOC requires that Simplot conduct a Remedial Investigation (RI) and Feasibility Study (FS) (i.e., RI/FS). In accordance with that AOC, Simplot has investigated the environmental effects of phosphate mining and milling operations at the Site, and is in the process of developing remedies to address environmental conditions that represent a risk to human health or the environment.



Figure 1-1: Regional Map of Southeast Idaho Showing the Smoky Canyon Mine

The Final RI Report (Formation 2014a) describes the environmental conditions at the Site. One finding was that selenium concentrations in groundwater discharging to the surface at Hoopes Spring and South Fork Sage Creek Springs are above the Idaho surface water quality criterion for protection of aquatic life (the chronic criterion is 0.005 mg/L; IDAPA 58.01.02.210) (IDEQ 2006), and exceed Idaho’s current acute criterion (0.02 mg/L). The selenium mass load discharged at these two springs is the primary source of selenium to surface waters in the lower Sage Creek drainage. As a consequence, the draft Feasibility Study Technical Memorandum

#1: Development and Screening of Remedial Alternatives (Formation 2016) included treatment of water at the springs as a potential remedial technology. The Site sources of selenium to the springs are overburden materials removed during active mining to access the underlying phosphate ore. The primary sources of selenium and other chemicals of potential concern (COPCs) within the overburden materials are the sulfides and organic matter present in the Mudstone and Middle Waste Shale from the Meade Peak Member. The overburden materials have been used to backfill pits or have been placed in external overburden disposal areas (ODAs). Water infiltrating through the overburden material mobilizes selenium and other COPCs. A portion of that water migrates to the Wells Formation aquifer. In the south portion of the Site, all affected Wells Formation groundwater discharges at Hoopes Spring and South Fork Sage Creek Springs.

Reducing the selenium mass transport to Sage Creek via Hoopes Spring and/or South Fork Sage Creek Springs is of highest priority for both Simplot and the USFS, because reduction of the selenium mass load associated with the springs will provide the greatest improvement in surface water quality within the lower Sage Creek drainage. The target reductions in selenium concentrations will ultimately depend on final remedial action objectives established for the Site (e.g., Idaho surface water quality standard, or a Site-specific standard).

The Phase 1 Pilot Study Work Plan and Sampling and Analysis Plan (Work Plan/SAP) for Biological Selenium Removal Treatment Technology Fluidized Bed Bioreactor (Formation 2014c), and the May 2014 addendum to the Surface Water Treatability Study Technical Memorandum (Formation 2014b), identified the first phase of the study for fluidized bed bioreactor (FBR) active biological treatment technology. Phase 1 was designed to demonstrate effective operation and treatment of 250 gallons per minute (gpm), with a commitment to subsequently increase the treatment capacity of the pilot system to the 1,000 gpm to 2,000 gpm range (i.e., Phase 2). Estimates by Formation (2014b) showed that between 2,000 and 4,000 gpm would require treatment in order to reduce selenium concentrations to below 0.005 mg/L immediately downstream of Hoopes Spring and South Fork Sage Creek Springs for current conditions (2,600 to 3,100 gpm from Hoopes Spring and 400 to 850 gpm for South Fork Sage Creek, depending on the assumptions made).

1.1 Purpose and Objectives of the Pilot Study

As discussed in the Phase 1 Pilot Study Work Plan/SAP (Formation 2014c), utilization of FBRs for selenium treatment is a developing approach for biological treatment. Historically, FBRs have been successfully employed for other oxyanions such as perchlorate and nitrate, which do not create a solid precipitate as a byproduct. The FBR configuration shows promise for higher kinetics in a smaller footprint; however, when applied to selenium removal, the FBR has inherent process challenges including particulate selenium retention and residuals management, both of which will impact the effluent water quality in regards to total (unfiltered)

selenium, organics (Biochemical Oxygen Demand/Chemical Oxygen Demand [BOD/COD]), and total suspended solids (TSS). The performance of the FBR and the ancillary filtration equipment operation was evaluated in Phase 1.

This Phase 2 Pilot Study Work Plan/SAP describes the equipment and procedures for increasing the treatment capacity for the plant to process water collected from South Fork Sage Creek Springs and from Hoopes Spring. An Ultra-filtration (UF) and Reverse Osmosis (RO) system will be installed in the water treatment building to concentrate soluble selenium prior to treatment in the existing FBR along with an additional new FBR. Design flows for the Phase 2 Pilot Study system include (Figure 1-2) a feed flow of approximately 2,100 gpm to the UF system from which approximately 100 gpm of backwash will go to the effluent blend tank and then to the effluent stream and 2,000 gpm of permeate to the RO system. From the RO system, 1,500 gpm of permeate will be discharged to the effluent blend tank and then will be discharged to the effluent stream, and the other 500 gpm of concentrate will go to the FBR units, followed by post-treatment with subsequent discharge to the effluent stream (see Section 3.0).

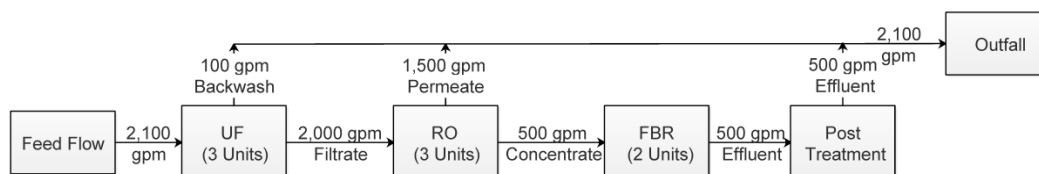


Figure 1-2: Pilot System Operational Flow Rates

Phase 2 of the Pilot Study is designed to provide additional information to support development and evaluation of remedial alternatives in the FS. In terms of the USEPA's 1992 *Guidance for Conducting Treatability Studies Under CERCLA* (USEPA 1992), this is a "remedy screening" treatability test.¹ Although the treatability test is being conducted primarily to screen technologies for further evaluation in the FS, the test will provide reduction of selenium concentrations in the lower Sage Creek watershed in the short-term.

The Pilot Study is being conducted to evaluate the effectiveness, implementability, and cost of actively treating water from South Fork Sage Creek Springs and Hoopes Spring to reduce selenium concentrations. The Pilot Study will provide data for use in development and evaluation of water-treatment remedial alternatives for potential use at the Smoky Canyon Mine. The specific objectives of this Pilot Study are to:

- Determine the effectiveness of the UF/RO system for concentrating soluble selenium into the concentrate stream.

¹ USEPA, 1992, p. 10, "During remedy screening, a single indicator contaminant is often monitored to determine whether a reduction in toxicity, mobility, or volume is occurring."

- Determine the effectiveness of the FBR for removing total selenium from the RO concentrate.
- Determine the technology's applicability in meeting remedial action objectives.
- Determine operating parameters to provide additional information regarding implementability and cost of the system.
- Evaluate process limitations with regards to levels of selenium and other COPCs in treated water, including any potential effects of other COPCs on the treatment efficiency of the system for selenium.

Although the primary purpose of this Pilot Study is to evaluate selenium removal, if there is also removal of other COPCs as a result of the treatment process, that information will be available for consideration during evaluation of remedial alternatives in the FS.

The types of data that will be collected to support these objectives and data uses are:

- Operation and maintenance parameters;
- Treated water/effluent characteristics;
- Process waste characteristics; and
- Operating cost.

1.2 Work Plan Organization

This document is comprised of eight sections, organized as follows:

- **Section 1.0 – Introduction:** a general description of the purpose of the Pilot Study.
- **Section 2.0 – Supporting Information:** a summary of Site information relevant to the Pilot Study activities and an overview of the UF, RO, FBR, and post-treatment system.
- **Section 3.0 – Pilot Study Design:** describes the various elements of the Pilot Study.
- **Section 4.0 – Data Quality Objectives:** describes the types and quality of data needed to support the study.
- **Section 5.0 – Roles and Responsibilities:** summarizes the roles and responsibilities.
- **Section 6.0 – Sampling and Analysis Plan:** describes the sample collection, field measurement, quality assurance and quality control, and related data review and documentation procedures.
- **Section 7.0 – Data Analysis and Reporting:** describes the evaluation and reporting of the data.
- **Section 8.0 – References:** presents a summary of the referenced documentation.

2.0 SUPPORTING INFORMATION

This section provides Site background information relevant to the Pilot Study activities, including an overview of the water sources designated for the Pilot Study; details about the UF, RO, and FBR technologies, and post-treatment system; and specific objectives for Phase 2 of the Pilot Study.

2.1 Springs Setting and Water Quality

Hoopes Spring and South Fork Sage Creek Springs are located along the west side of Sage Valley, and less than one-quarter mile east-southeast of Panel E of the Smoky Canyon Mine (Figure 2-1).

The springs discharge groundwater from the Wells Formation aquifer. This aquifer is comprised of mainly limestone and sandstone with a complex network of faulting, fracturing, and solution voids that can act as conduits for groundwater flow. The groundwater within the Wells Formation aquifer consists of both regional recharge and local recharge (Mayo et. al. 1985). Local recharge that has come in contact with seleniferous mine overburden from the Smoky Canyon Mine discharges selenium at Hoopes Spring and South Fork Sage Creek Springs (Formation 2014a).

2.1.1 South Fork Sage Creek Springs

This section provides a description of the physical layout and water quality measurements at the South Fork Sage Creek Springs.

Groundwater discharges from the South Fork Sage Creek Springs directly to the creek from both its north and south banks, and routine samples have been collected at multiple discharge points (Figure 2-2). Upper South Fork Sage Creek is a losing stream where it flows over outcrops of Wells Formation bedrock and, during most of the year, the area upstream of the springs is dry. During high-flow conditions water reaches the springs from Upper South Fork Sage Creek, providing dilution of selenium concentrations. The total spring discharge to South Fork Sage Creek is estimated to be relatively steady at approximately 2,130 gpm (Formation 2014a), although most of this flow is not accessible for collection. The spring water discharging to the creek from the north side of the channel is the primary source of the selenium mass load to South Fork Sage Creek. Selenium concentrations measured from 2007 to 2016 at LSS-SP-N (and formerly LSS-SP-N3 and LSS-SP-N4) ranged from 0.0126 mg/L (in 2007) to 0.0909 mg/L (in 2015-2016) (see Figure 2-3, Appendix A, Appendix B).

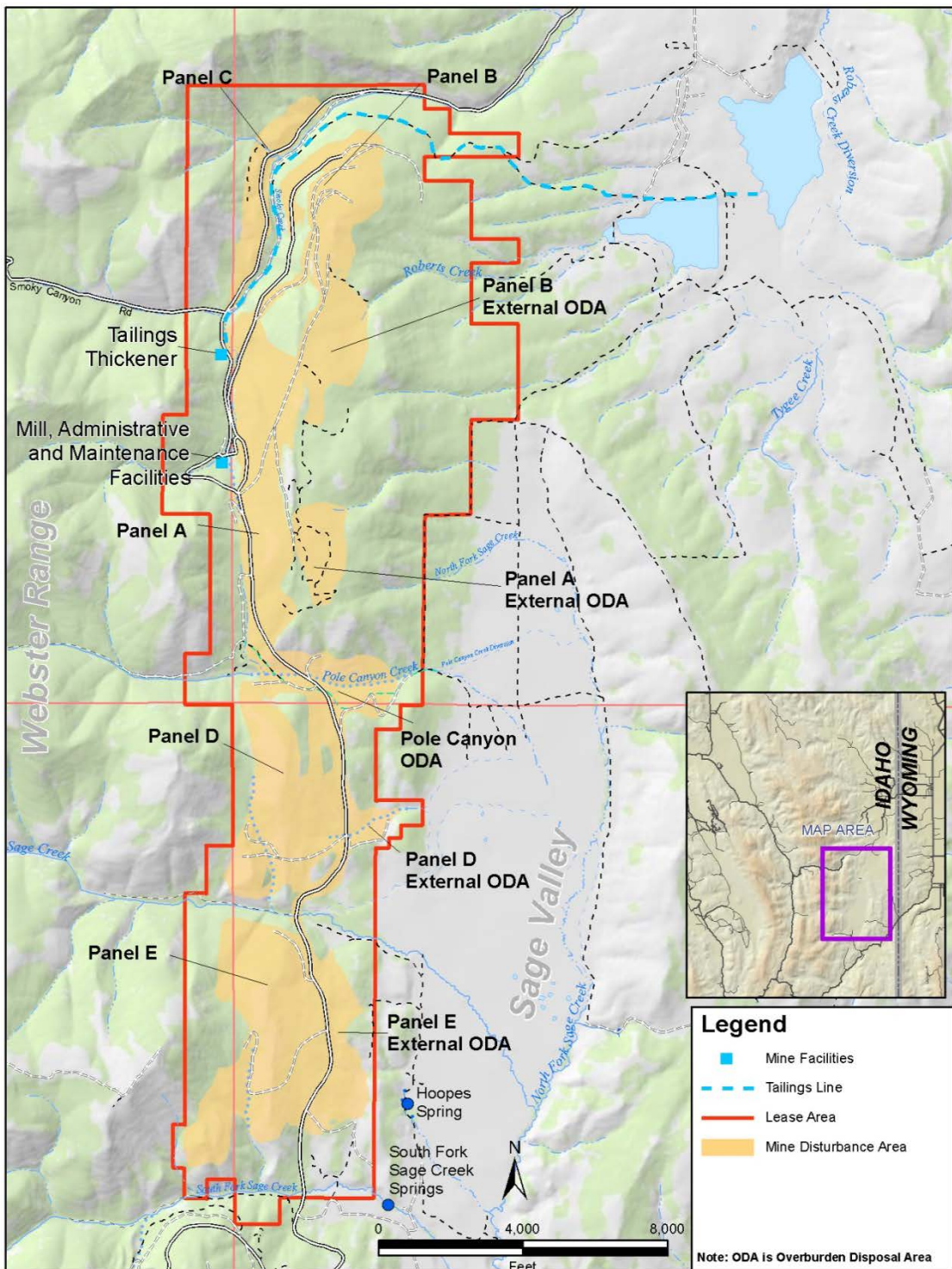


Figure 2-1: South Fork Sage Creek Springs and Hoopes Spring Setting

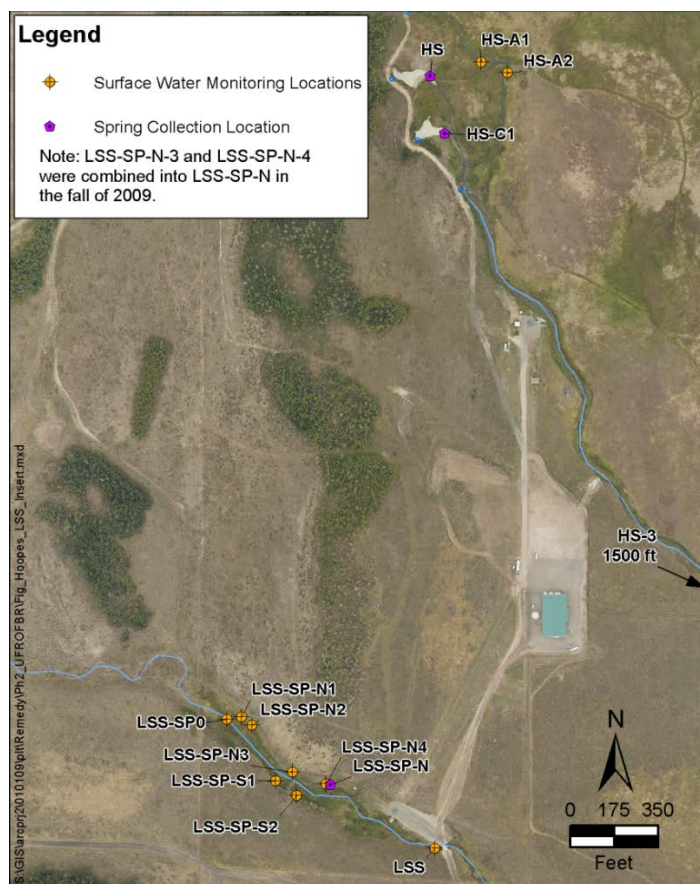


Figure 2-2: South Fork Sage Creek Springs and Hoopes Spring Locations for Monitoring and Water Collection

Recent observations indicate that the flow rates from the single spring collection location (LSS-SP-N) are on the order of 150 gpm (spring and summer), 120 gpm (fall), and 110 gpm (winter). In the past several years, total selenium concentrations in South Fork Sage Creek at the monitoring station known as LSS, immediately downstream from the springs, have ranged from 0.0105 mg/L to 0.0243 mg/L (see Appendix A and Appendix B).

Selenium concentrations have been increasing in the springs discharge in recent years (Figure 2-3); selenium is the primary COPC and it exceeds water quality criteria in South Fork Sage Creek Springs water (Formation 2014a).

Selenium concentrations within the discrete springs vary both seasonally and spatially. Seasonally, the annual maximum selenium concentration typically occurs in late-summer (September) which coincides with the annual maximum Wells Formation groundwater elevation. Spatially, the northern area of the springs has the highest selenium concentrations while the middle and southern areas have similar and relatively lower selenium concentrations.

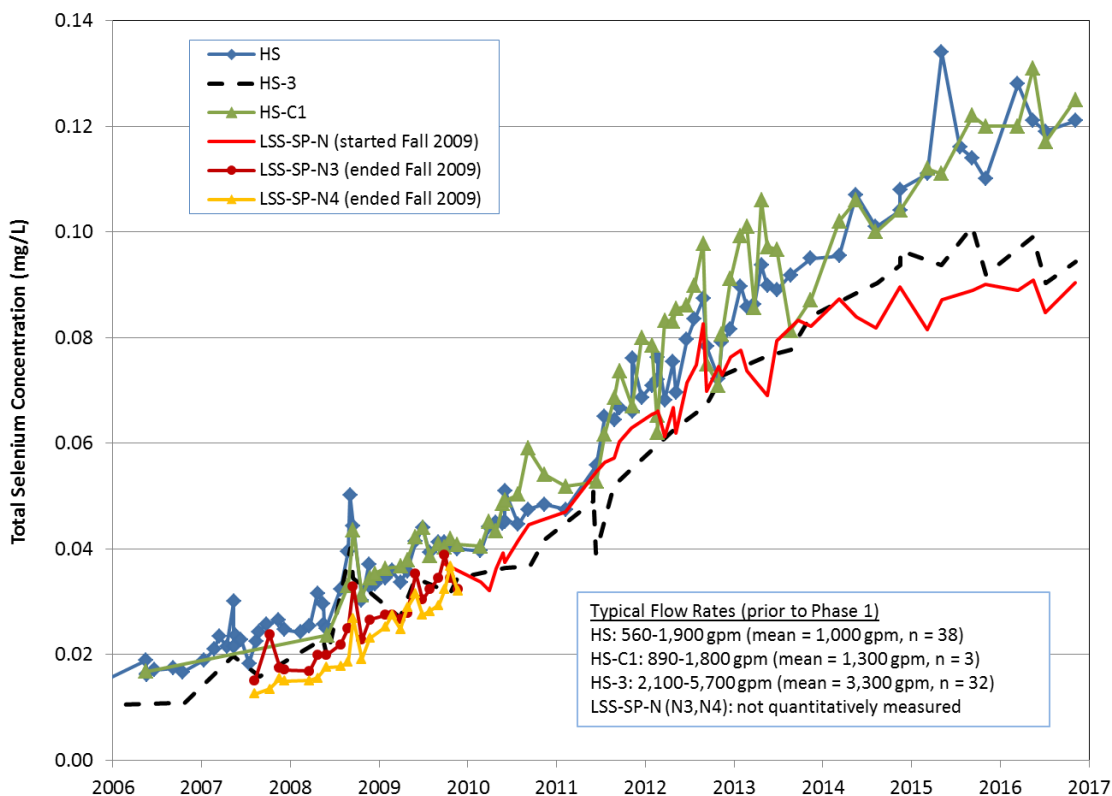


Figure 2-3: Time Series Comparison of Total Selenium Concentrations at Selected Hoopes Spring and South Fork Sage Creek Springs Monitoring Locations

2.1.2 Hoopes Spring

This section provides a description of the physical layout and water quality measurements at Hoopes Spring.

Hoopes Spring is located along the west side of Sage Valley between Sage Creek and South Fork Sage Creek, and less than one-quarter mile east of Panel E of the Smoky Canyon Mine (Figure 2-1). Similar to South Fork Sage Creek Springs, Hoopes Spring drains groundwater from the Wells Formation aquifer. Local recharge that has come in contact with seleniferous mine overburden from the Smoky Canyon Mine is the primary source of selenium at Hoopes Spring.

Hoopes Spring consists of a network of discrete springs that all discharge Wells Formation aquifer groundwater. There are four primary springs monitoring locations (HS-A1, HS-A2, HS-C1, and HS) (Figure 2-2) and numerous secondary springs within the Hoopes Spring Complex which are not monitored routinely. Flow measurements have been made routinely on the middle

primary spring (HS) and at the mouth of the Hoopes Spring drainage (HS-3) just before it flows into Sage Creek. From 2010 to 2014 the flow rate at HS varied from approximately 560 gpm to 1,900 gpm with an average of 1,000 gpm. There was no pattern of seasonal variability in flow observed at HS. Since monitoring was initiated at HS-C1, from 2009 to 2013 only three flow measurements were recorded, ranging from 890 to 1,800 gpm with an average of 1,300 gpm. In 2014, the springs at monitoring locations HS and HS-C1 were developed to provide influent to the Phase 1 Pilot Study. The water was conveyed from the springs via a pipe which, by its placement, prevents access to measure flows at HS and HS-C1, although in the fall of 2016 the flows at these two sources were estimated (weir flow plus other flow over the dikes) at 800 to 1,000 gpm and 1,300 to 1,600 gpm, respectively, for a total combined flow of 2,100 to 2,600 gpm. Downstream from HS, HS-A1, HS-A2, and HS-C1 along with numerous smaller groundwater discharge points in the Hoopes area, monitoring is ongoing at HS-3 (Figure 2-2). From 2010 to 2015, the flow rate at HS-3 varied from approximately 2,100 gpm to 5,700 gpm with an average of 3,300 gpm. Flows measured at HS-3 best represent the combined flow from the multiple discharge points that comprise Hoopes Spring.

Total selenium concentrations at Hoopes Spring monitoring locations HS and HS-C1 measured from 2006 to 2016 ranged from 0.017 mg/L (2006) to 0.12 to 0.134 mg/L (2015-2016) (see Figure 2-3, Appendix A, Appendix B). Recent selenium concentrations at HS-3 have ranged from 0.09 to 0.10 mg/L (see Figure 2-3, Appendix A). Data for other COPCs are presented in the Final RI Report (Formation 2014a), which showed that selenium is the primary COPC and it exceeds water quality criteria.

As part of the RI, 20 discrete locations of groundwater discharge within the Hoopes Spring complex were delineated and sampled. The purpose of this delineation was to identify specific discrete discharge locations with elevated selenium concentrations and to estimate the proportion of the total spring discharge with elevated selenium (Formation 2014a). Spatially, the northern area of the springs has the lowest selenium concentrations while the middle and southern areas have similar and relatively higher selenium concentrations.

2.2 Pilot System Considerations

In 2014, Simplot proposed a plan for testing water treatment technology at the springs (Simplot 2014), and subsequently started construction for a water treatment plant located between Hoopes Spring and South Fork Sage Springs. The Phase 1 FBR equipment was installed and started up in late 2014/early 2015. The Phase 1 Pilot Study system treated 200 to 250 gpm of comingled flow from South Fork Sage Creek Springs and Hoopes Spring on and off through 2015 and the first part of 2016 as start-up and troubleshooting occurred. Details about the Phase 1 start-up and troubleshooting are presented in the monthly reports provided in Appendix C (note that within 90 days after completion of the Phase 1 Pilot Study, the findings of the study will be submitted to the agencies in a Treatability/Pilot Study Report). At the time of this Phase 2

Work Plan/SAP submittal, the Phase 1 Pilot Study system has been effectively operating since March 2016, and the performance guarantee monitoring has been completed. Figure 2-4 presents total selenium concentrations in the influent and effluent water of the Phase 1 Pilot Study system, since initiation of the pilot study in early 2015; similarly, Figure 2-5 shows the selenium load removed from the springs influent as a result of Phase 1 Pilot Study system operation. Since March 2016, selenium concentrations in the effluent have been consistently in the range of 0.005 to 0.010 mg/L, with a mean of 0.0083 mg/L (see Figure 2-4, Appendix D).

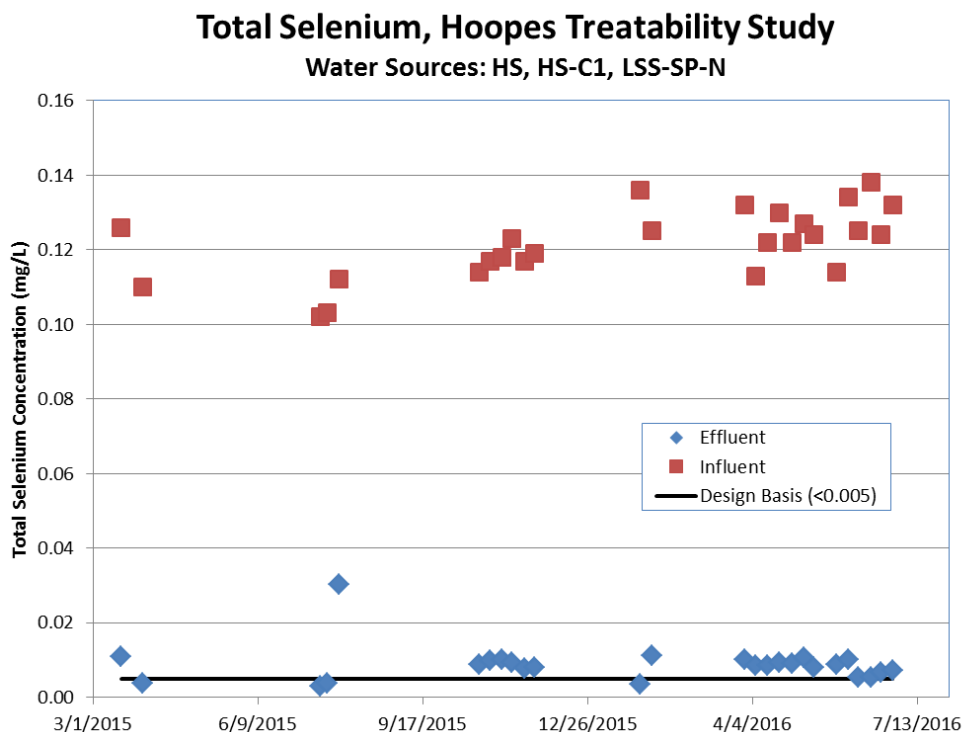


Figure 2-4: Total Selenium Concentrations, Phase 1 Performance Testing Period

With implementation accomplished for the Phase 1 FBR system, Simplot is now ready to initiate Phase 2. A UF/RO system, and a second Frontier Water Systems SeHawk™ FBR unit, will be added to the treatment plant with commissioning scheduled for summer of 2017. The pilot plant will be operated year-round to gather performance data. The UF/RO system will concentrate the comingled spring water, discharging RO permeate and feeding RO concentrate to the FBR for further treatment. Based on the results of the previous RO pilot study, it is designed such that the UF/RO system will concentrate influent selenium four times prior to treatment in the two FBR systems (Stantec and RSCI 2016).

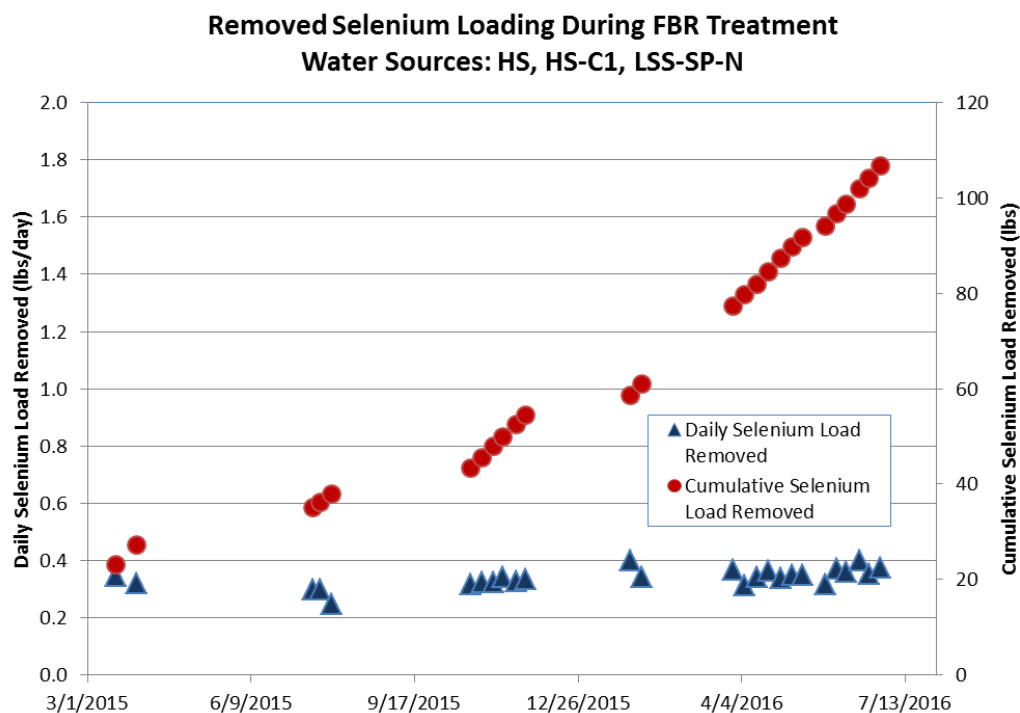


Figure 2-5: Removed Selenium Load, Phase 1 Performance Testing Period

The spring collection system that was developed for the Liberty pilot treatability study at South Fork Sage Creek (see Section 1.1.2 in Appendix B) is estimated to be currently producing approximately 110 to 150 gpm, depending on the season. This water contains the highest selenium concentrations at South Fork Sage Creek Springs. In the Phase 1 Pilot Study, Simplot combined water at South Fork Sage Creek (LSS-SP-N), water from the “C1” seep at Hoopes Spring (HS-C1), and water from the “HS” seep at Hoopes Spring (HS) (see Figure 2-2) for a total influent flow of 250 gpm. Appendix B presents a discussion of estimated selenium removal from the watershed that would result from treating these sources. The selenium concentrations in HS and HS-C1 water are similar to those at LSS-SP-N (see Figure 2-3). A description of the collection and pumping systems, and Phase 2 plans for collecting and conveying the increased flow required from the South Fork Sage Creek Springs and Hoopes Spring areas, is provided in Sections 3.1.2 through 3.1.4.

2.3 Technology Overview

The technologies involved in the Pilot Study include Ultra-Filtration (UF), Reverse Osmosis (RO), Fluidized Bed Reactor (FBR), and activated sludge post treatment. This section describes, in general, the fundamentals of the technologies involved with more project specific information provided in Section 3.1.

2.3.1 UF Technology Overview

Ultra-Filtration is the process by which a contaminated liquid stream is forced through a porous membrane with a pore size less than 0.1 micron. The filtrate is collected on the low pressure side of the membrane while particles greater than the pore diameter are retained on the feed side. The retained solids are periodically backwashed to maintain membrane permeability. The membranes provided in the Pilot Study will be an outside-in hollow fiber configuration housed within pressure vessels. The feed water is introduced to the pressure vessel where water passes from the outside to inside of the hollow fiber membranes. After passage through the membranes, water travels through the annular space to the discharge header of the membrane pressure vessel. Solids are retained within the pressure vessel until the unit goes through a backwash cycle. The backwash cycle consists of a reversal of flow from the inside to outside of the hollow fibers which expels the solids from the membrane surface. Simultaneously, an air scour and flushing flow is provided within the pressure vessel to flush the solids out of the vessel. Backwash water is provided from a permeate storage vessel. The recovery percentage of UF membranes is usually greater than 95 percent of feed flow with less than a 5 percent of backwash volume. (Percent Recovery = Permeate Volume / Feed Volume). Ultra-Filtration systems are commonly placed in advance of RO treatment systems to protect the more sensitive RO membranes from particulate material.

2.3.2 RO Technology Overview

Osmosis is a process in which a solvent (water) passes through a semi-permeable membrane into a solution of higher solute (dissolved salts), until the concentrations on either side of the membrane are equal.

The process of RO is the engineered application of this principle to achieve water purification by the application of external pressure to the more concentrated solution to reverse the osmotic process. This results in a reversal of solvent (water) flow into a solution of lower solute concentration, thereby purifying one side while concentrating the other.

Reverse osmosis membranes reject dissolved salts and metal ions, as well as organic compounds and bacteria. The degree to which a particular substance is rejected by the membrane depends on the type of membrane used, and the resulting difference between the liquid transport characteristics of the membrane and the solute transport characteristics of the membrane. The final effluent quality from a RO system is the result of the unique combination of these factors. In general, the salt passage is inversely related to pressure (i.e., salt passage increases as applied pressure decreases). The reduced pressure causes a decrease in permeate flow since permeation is directly proportional to applied pressure.

Reverse osmosis membranes are configured into a spiral-wound module configuration, where multiple membrane sheets are wrapped around a central permeate collector tube. The benefit of the spiral configuration is an increased packing density of the membrane area within a relatively small pressure vessel. As water is pumped along the membrane surface length, the residual concentrate volume decreases as the permeate is continually extracted via the tubes.

2.3.3 FBR Technology Overview

The Pilot Study utilizes a prefabricated, fluidized bed biological treatment system created by Frontier Water Systems (Frontier). Biological treatment systems use specialized microorganisms to reduce and precipitate metals, metalloids, and non-metals from solution. The process of biological selenium reduction converts oxidized forms of selenium to the elemental state. The treatment chemistry is the same as for the ABMet[®] system (see Formation 2011 for a detailed discussion).

The treatment process consists of passing water at controlled flow rates through a confined bioreactor. Fixed bed bioreactors have been proven effective at removing dissolved metals from water (i.e., the ABMet[®] system tested at the Site in 2009), but have potential disadvantages of higher cost, relatively large footprints, and difficult operation and maintenance (O&M) for the polishing system. The Frontier system utilizes FBRs to address these issues. The fluidized bed gives a higher surface area exposure to the flow stream, thus requiring a smaller and more efficient reactor volume. The Frontier bioreactor contains microbial biofilms immobilized on a substrate (granular activated carbon of a specific diameter). Nutrients including carbon, nitrogen, and phosphorus are fed into the reactor to encourage optimal reducing conditions for the microorganisms. As influent water flows upward through the bioreactor bed, the substrate fluidizes and oxidized selenium is converted to a particulate elemental form.

The second stage of the Frontier system consists of a filtration system which captures biological and seleniferous solids media. Selenium is ultimately removed from the system by backwashing the filter media.

2.3.4 Activated Sludge Technology Overview

Activated sludge describes the water treatment methodology where a diverse group of bacteria and protozoa clump together while suspended in an aerobic liquid stream and oxidize soluble and particulate carbonaceous and nitrogenous materials through biochemical pathways. The consumption of these materials generates new cell mass and carbon dioxide. The microorganisms are clumped together in flocs which allow them to be settled in clarification tanks downstream of the turbulent aeration tanks. A portion of the biomass settled in the clarifiers is removed from the system (Waste Activated Sludge – WAS) while the remaining sludge is recycled back to the head of the aeration tank (Return Activated Sludge – RAS). The

fundamentals of activated sludge are applied to a diverse range of water treatment activities and are the most widely applied wastewater treatment methodology. Operation of an activated sludge treatment system requires the operator to cultivate an environment which allows for the most beneficial microorganisms (flocculating) to outcompete other less beneficial organisms (filaments, nocardia, etc.). Parameters available to the design and operator of activated sludge treatment systems include, sludge retention time (SRT), food to microorganism ratio (F/M), RAS rates, oxygen concentrations, and a variety of other parameters.

3.0 PILOT STUDY DESIGN

This Pilot Study will evaluate the effectiveness of the system in removal of COPCs, particularly selenium, while treating water combined from specific locations in the South Fork Sage Creek Springs and Hoopes Spring complexes. As discussed in Section 2.1, selenium is the primary COPC and it exceeds water quality criteria in water discharging at the springs (Formation 2014a). This section provides a description of the Phase 2 Pilot Study system. A process flow diagram is provided in Figure 1-2. The description of the Phase 1 Pilot Study system is provided in Appendix B.

3.1 Pilot Treatment System Overview

The pilot treatment system consists of pumping stations located at Hoopes Spring and South Fork Sage Creek pumping to a centralized water treatment building (Figure 3-1). The water treatment building houses the majority of the equipment with three tanks located outside of the building. The pilot treatment system utilizes the previously generally described UF, RO, FBR, and post-treatment technologies. The UF system removes particulate material in advance of the RO system to protect the RO modules from fouling. The RO system concentrates solutes in the water, which include selenium, at a 4 to 1 ratio. The RO concentrate is pumped to the two FBR modules where selenium is precipitated and removed from the flow stream via backwashing. Backwashed selenium laden solids are removed from the system for disposal. The FBR effluent is treated via the activated sludge post-treatment system prior to discharge to the outfall located on the channel downstream of Hoopes Spring.

3.1.1 Design Basis

Table 3-1 presents the influent and effluent design basis for the Phase 2 Pilot Study. As previously discussed, the influent consists of a combination of LSS-SP-N, HS, and HS-C1 water. The sources are springs discharging from groundwater, with very little seasonal variation in temperature. Based on the Phase 1 Pilot Study operation, no additional temperature adjustment will be needed to maintain biological activity in the reactors through the winter. A detailed description of the Phase 2 Pilot Study system is provided in this section.

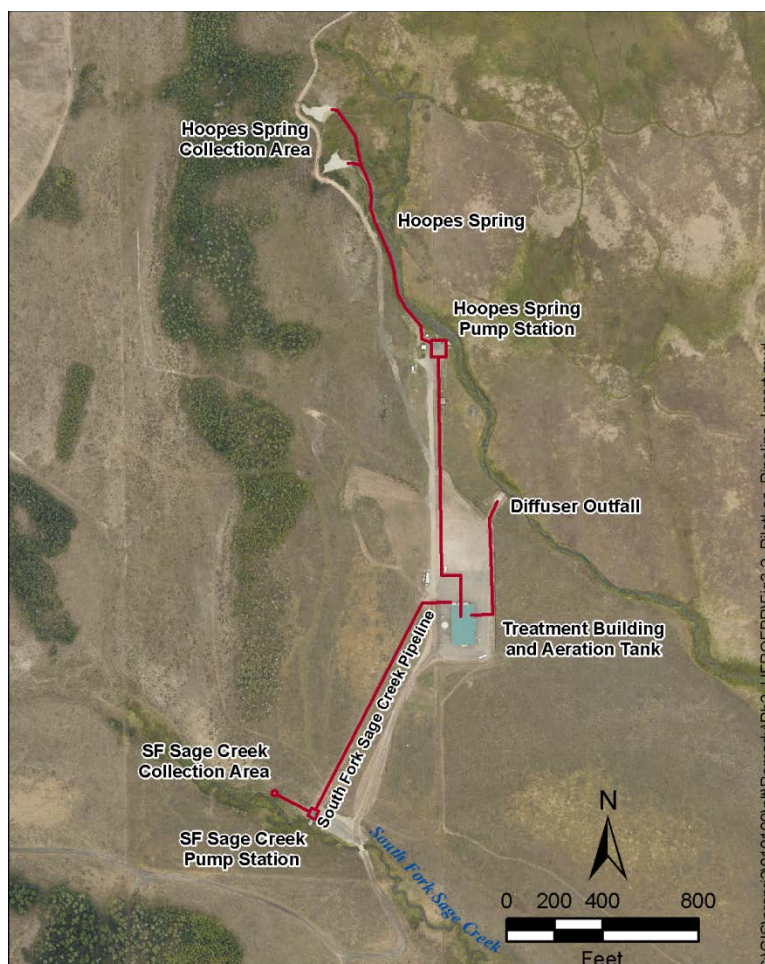


Figure 3-1: Pilot Study Location and Pipeline Configuration

3.1.2 South Fork Sage Creek Pump Station Description

The South Fork Sage Creek Springs collection system (Figure 3-2) is in place and consists of an 8-inch diameter perforated plastic pipe trenched into the hillside above South Fork Sage Creek. The perforated piping is bedded in gravel and conveys water to a corrugated metal pipe (CMP) diversion box located to the east of the collection area. From the CMP diversion box, an 8-inch diameter high-density polyethylene (HDPE) gravity pipe conveys water to the wetwell of the South Fork Sage Creek pump station. The South Fork Sage Creek pump station pumps water to the pilot treatment system via a 6-inch HDPE pressure pipe. The South Fork Sage Creek pump station is a vertical turbine pump station with duplex pumps housed inside of a small building for freeze protection. Excess water flowing into the South Fork Sage Creek pump station overflows the wetwell and discharges to a gravel and riprap-lined channel which extends to the edge of South Fork Sage Creek.

Table 3-1: Pilot System Design Basis

Parameter	Influent Range	Effluent Range
Flow	2,000 – 2,150 gpm	2,000 – 2,150 gpm
Total Selenium	$\leq 125 \mu\text{g/L}^a$	$\leq 7 \mu\text{g/L}^b$
Biochemical Oxygen Demand ^c	$< 2 \text{ mg/L}$	$< 10 \text{ mg/L}$
Total Suspended Solids	$< 10 \text{ mg/L}$	$< 5 \text{ mg/L}$
Total Phosphorus	$< 0.1 \text{ mg/L}$	$< 0.25 \text{ mg/L}$
Nitrate/Nitrite as N	$< 1 \text{ mg/L}$	$< 10 \text{ mg/L}$
Ammonia	$< 1 \text{ mg/L}$	$< 2 \text{ mg/L}$
Nitrate	$< 1 \text{ mg/L}$	$< 10 \text{ mg/L}$
Turbidity	$< 2 \text{ NTU}$	$< 2 \text{ NTU}$
Total Sulfide	$< 1 \text{ mg/L}$	$< 1 \text{ mg/L}$
pH	6 – 9	6 – 9
Dissolved Oxygen	Saturation	90% Saturation

Notes:

^a Average selenium concentration in influent water during Phase 1 Pilot Study.

^b Assumes 95 percent removal of total selenium, with maximum influent total selenium concentration of $125 \mu\text{g/L}$.

^c Biochemical oxygen demand (BOD) effluent targets are related to maintaining dissolved oxygen (DO) concentrations in the receiving stream. These effluent limits will be assessed further during the pilot study.



Figure 3-2: South Fork Sage Creek Collection and Conveyance

3.1.3 Hoopes Spring Pump Station Description

Water collection from Hoopes Spring (Figure 3-3) originates from the HS and HS-C1 locations. In preparation for the Phase 1 Pilot Study, earthen dikes were constructed at two locations within the Hoopes Spring complex for collection of the waters discharged from HS and HS-C1. Built into the two dikes are concrete control structures which direct water into HDPE pipes for conveyance to the Hoopes Spring pump station via gravity. Slide gates are constructed into each of the concrete control boxes which allow operators to stop flow from entering the pipe and allow water to discharge over the control box weir to the Hoopes Spring streambed. Water conveyed to the Hoopes Spring pump station enters the below-grade concrete wetwell. Two vertical turbine pumps draw water from the wetwell and convey pressurized flow to the treatment building wetwell via a 12-inch diameter HDPE pressure line. The Hoopes Spring pump station is designed to convey up to 2,400 gpm of water to the treatment building, and flow is modulated using pump speed control. Excess water flowing into the Hoopes Spring wetwell overflows the wetwell and is discharged via a riprap-lined channel extending to the stream channel downstream from Hoopes Spring.

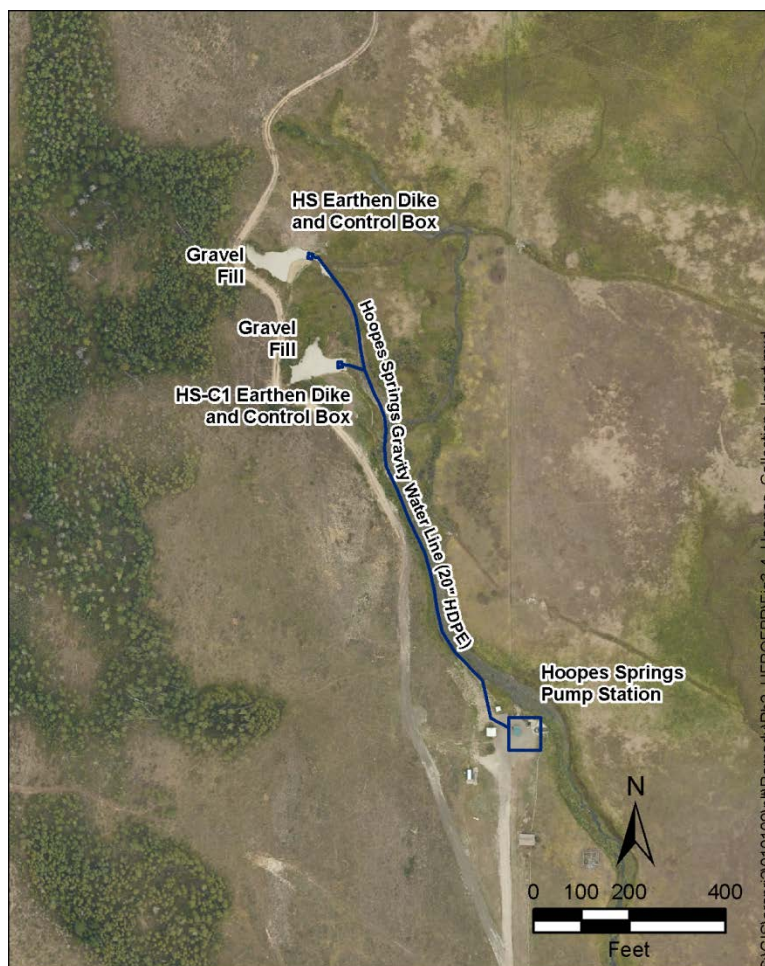


Figure 3-3: Hoopes Spring Collection and Conveyance

3.1.4 Collection and Pumping Rates

The collection and pumping rates from South Fork Sage Creek Springs and Hoopes Spring are listed in Table 3-2. The pumping rates for the Phase 1 Pilot Study system were easily achieved. The Phase 2 Pilot Study pumping rates are estimated based on site-specific observations, and adequate water should be available to meet the treatment flow rates required.

Table 3-2: Collection and Pumping Rates

Location	Phase 1	Phase 2
Collection and Pumping Rate From South Fork Sage Springs	110-150 gpm	110-150 gpm
Collection and Pumping Rate From Hoopes Spring	100-140 gpm	~1,950-1,990 gpm
Total Plant Influent	250 gpm	~2100 gpm

Notes:

The pump station at Hoopes Springs is equipped with two (1 duty and 1 backup) 2,400 gpm vertical turbine pumps.

The pump station at South Fork Sage is equipped with two (1 duty and 1 backup) 150 gpm vertical turbine pumps.

gpm = gallon per minute

3.1.5 Treatment Site Description

Process equipment for the Phase 2 Pilot Study system will be contained in a pre-engineered steel building (approximately 200-foot by 90-foot which includes an upcoming extension of 45 feet to accommodate the Phase 2 Pilot Study). The process equipment located within the building includes the two FBRs, three UF skids, and three RO skids; pumping systems and break tanks; and chemical systems. There will be two 75,000-gallon, covered aeration tanks located outside of the building as well as a 40-foot diameter, covered clarifier tank. Treated water is discharged back to the main stem of Hoopes Spring via the riprap-lined outfall channel, located 600 feet to the north of the treatment building. The layout of the treatment building is shown in Figure 3-4.



Figure 3-4: Treatment Building Layout

3.1.6 Ultra-Filtration System Description

The collected spring water is delivered to the existing influent wetwell located within the treatment building. The influent will be pumped to three UF skid units that will remove solids from the raw water to protect the performance of the RO units by reducing the fouling of the RO membranes. The three UF skids operate in a batch process where they generate permeate for 20 to 60 minutes and are then backwashed for 20 to 30 seconds using RO permeate to remove solids from within the membrane modules. The design recovery for the UF skids is 95 percent or more, resulting in 2,000 gpm of UF permeate. The backwash water will be discharged to a storage tank which is blended with the RO permeate in the Effluent Blend Tank for discharge to the channel downstream from Hoopes Spring. Design flows of the UF system are shown in Table 3-3.

Table 3-3: UF System Design Parameters

Parameters	
Number of Skids	3
Module Capacity per Skid	54
Module Make and Manufacturer	Toray, HFU-2020N
Pore Size	0.01 µm
Clean In Place Skids	1
Feed Pumps	2 – vertical turbine, 2,400 gpm capacity VFD speed control
Flow Rates	
Total Instantaneous Feed Flow Rate	2,306 gpm
Total Gross Feed Flow Rate	2,087 gpm
Total Net Average Permeate	2,000 gpm
Total Net Average Permeate Per Skid	667 gpm
Backwash Flow Rate	834 gpm
Estimated Water Recovery at Design	>95 percent

The UF membranes will be cleaned approximately every 2 weeks with citric acid or sodium hypochlorite. The maintenance cleaning waste will be quenched with sodium bisulfite and neutralized. The clean in place (CIP) waste will be stored in the Neutralized CIP Rinse Waste Storage Tank. Water from the Neutralized CIP Rinse Waste Storage Tank will be metered to the aeration tank for treatment prior to discharge. Every three months, the UF membranes will

be cleaned with citric acid, hydrochloric acid, or sodium hypochlorite. Waste from this cleaning process will be stored in the CIP Chemical Waste Storage Tank, and will be sampled and trucked offsite for disposal. The UF membranes will be rinsed 3 or 4 times following the cleaning. Neutralized CIP rinse water will be metered to the aeration tanks for treatment prior to discharge. A generalized process flow diagram for the UF system is shown in Figure 3-5.

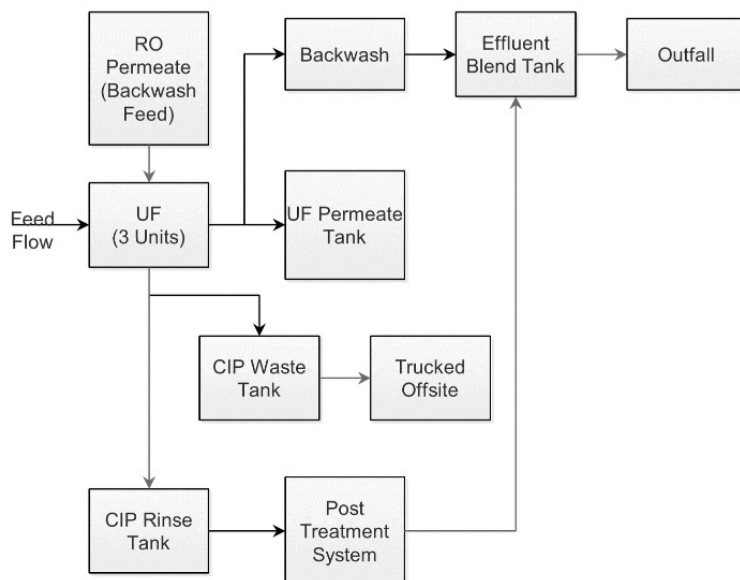


Figure 3-5: UF System Process Flow Diagram

3.1.7 RO System Description

The permeate from the UF skids will be pumped to three RO skid units. The UF permeate will be dosed with sodium bisulfite for chlorine removal, if required, and an anti-scalant chemical for controlling scale formation on the RO membranes. Each RO skid is equipped with a pretreatment filter cartridge to remove any remaining solids. The design recoveries for the RO units are 75 percent, resulting in approximately 1,500 gpm of permeate and 500 gpm of concentrate. Design flows of the RO system are shown in Table 3-4.

The RO membranes will be cleaned in place, approximately once every three months, with alkaline and acid to remove accumulated inorganic and organic foulants on the membranes. The CIP chemicals from the RO maintenance will be pumped to the same CIP Chemical Waste Storage Tank as the UF CIP chemicals. The rinse water will be neutralized and pumped to the Neutralized CIP Rinse Waste Storage Tank for further treatment in the aeration tank.

Table 3-4: RO System Design Parameters

Parameters	
Number of Skids	3
Feed Water Flow	667 gpm per skid, 2,000 gpm total
Concentrate Flow	167 gpm per skid, 500 gpm total
Feed Pressure	172 psi
Recovery	75 percent
Pressure Vessels	24 per skid, 72 total
RO Elements	126 per skid, 378 total
Feed Pumps	3 pumps, 667 gpm per pump VFD Speed Control
Anti-scalant Pumps	1 per skid, 3 pumps total

The RO permeate will be dosed with sodium hydroxide for pH adjustment before discharging to the RO Permeate Storage Tank. The RO permeate will overflow from the tank to the Effluent Blend Tank for mixing with the UF backwash. The RO permeate will be used for the UF backwash (as previously mentioned), and for the CIP rinses of the UF and RO membranes.

The RO concentrate will discharge to an RO Concentrate Storage Tank, and will then be pumped to two parallel FBR systems for biological selenium removal. A generalized process flow diagram of the RO system is provided in Figure 3-6.

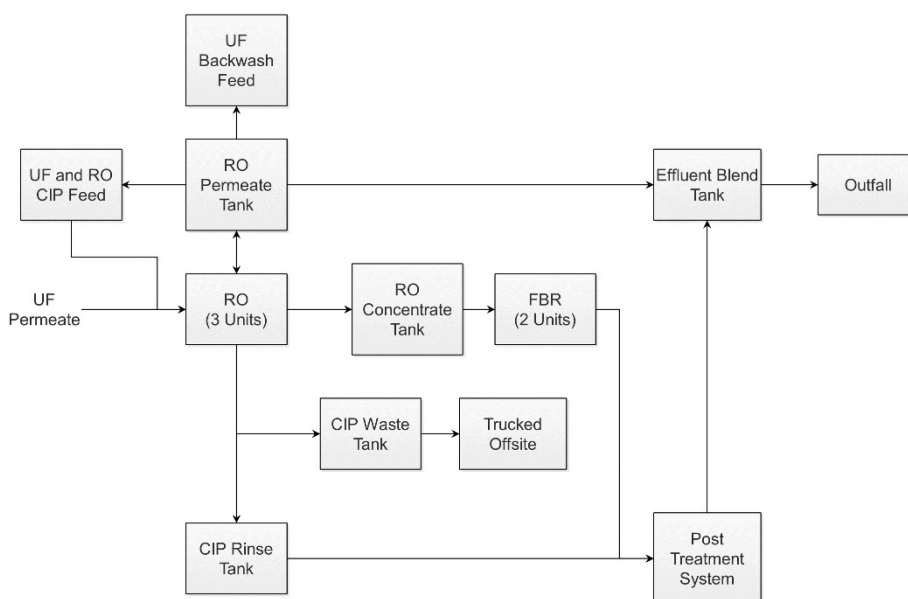


Figure 3-6: RO System Generalized Process Flow Diagram

3.1.8 FBR System Description

The FBR systems will consist of the existing system that was constructed for the Phase 1 Pilot Study, and a second identical system added for Phase 2. Each FBR system is comprised of 3 trains (for a total of 6 trains), each with a capacity of 83 gpm. Combined, the treatment capacity will be approximately 500 gpm. The RO concentrate will be split between the available trains and controlled using a modulating flow control valve.

A reducing environment will be created within a fluidized stage that concurrently expels gas and maintains optimum biofilm conditions for selenium reduction and retention. A second stage operating in downflow serves to filter the precipitated selenium and biomass. The FBR system generates biomass while precipitating the influent selenium. The first stage is periodically surged in flow and the second stage is periodically backwashed to transfer the biomass and precipitated solids to a backwash clarifier tank. The pumps that pull water from the FBRs and deliver it to the aeration tank can be operated in reverse to provide flow for the backwashing operations. Design flows of the FBR system are shown in Table 3-5.

Table 3-5: FBR System Design Parameters

Parameters	
FBR Modules	2
Trains Per Module	3
Stages Per Train	2
Flow Rates	
Feed Flow	83 gpm per train, 250 gpm per module 500 gpm operating total
Backwash Flow	300 gpm
Feed Pumps	3 total – 2 duty, 1 standby 250 gpm, VFD speed control
Chemical Feed Pumps	6 total Micro C Feed, 3 per module 2 total Phosphoric acid, 1 per module 2 total Ammonium sulfate, 1 per module 2 total Micro Nutrient, 1 per module

The volume of backwash generated in each cycle typically ranges from 800 to 3,400 gallons. The backwash is collected in a settling tank where the clarified water is decanted to the aeration tanks. Solids in the backwash settling tank will be periodically transferred to the sludge storage tank. The solids in the backwash settling tank gravity settle to approximately 2 percent total solids concentration without settling aids. A generalized process flow diagram of the FBR system is shown in Figure 3-7.

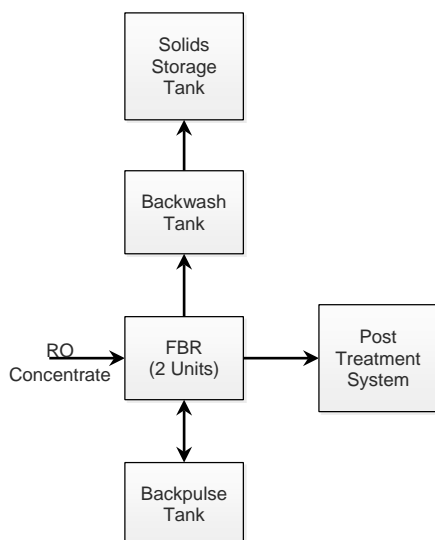


Figure 3-7: FBR Generalized Process Flow Diagram

3.1.9 Post-Treatment System Description

Water from the FBR system is pumped to the post-treatment activated sludge system which consists of two 75,000-gallon aeration tanks, operated in parallel, and a 40-foot diameter clarifier and sand filters. The aerobic treatment system provides oxygen and internal solids recycle to generate a biological community which oxidizes influent hydrogen sulfides and residual COD discharged from the FBRs. The aeration system is sized to provide complete mixing within the tanks which maintains all solids in suspension. The aeration tanks are equipped with a mushroom style vent to allow blower air to escape from the tank. The post-treatment system design parameters are shown in Table 3-6.

The aeration tank effluent flows by gravity to the gravity clarifier, where solids are settled and returned to the head of the aeration tanks, and the clarifier effluent is pumped to the continuously backwashed sand filters, where alum or ferric chloride are added, for removal of phosphorus and carryover biological solids from the clarifier. The sand filter filtrate flows by gravity to the outfall and the sand filter backwash is pumped back to the aeration tank where the solids can be settled in the clarifier. Settled solids in the clarifier are either pumped back to the aeration tank influent line as RAS or they are waste activated sludge (WAS) that is removed from the system to the sludge thickener tank. Thickened WAS is discharged to the sludge storage tank for holding until transported for offsite disposal. A generalized process flow diagram of the post-treatment system is shown in Figure 3-8.

Table 3-6: Post-Treatment System Design Parameters

Parameters	
Aeration Tanks	2 units, 75,000 gallon
Aeration Blowers	4 total, 2 per aeration tank 20-HP each
Clarifier	1 unit, 40-foot diameter 500 gpm average design flow
Decant Thickener	1 unit, 12-foot diameter 1-HP
RAS Pumping	2 pumps, 2-HP each 250 gpm capacity each
Clarifier Effluent Pumping	2 pumps, 3-HP- each 300 gpm capacity each

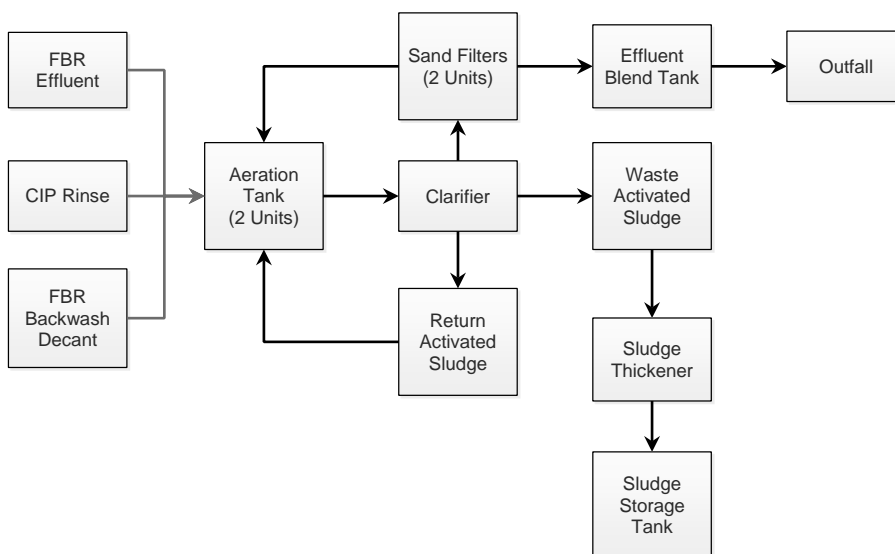


Figure 3-8: Post-Treatment System Generalized Process Flow Diagram

The water treatment plant will house multiple chemical storage tanks. Table 3-7 presents details for each tank including contents and volumes. Secondary containment will be provided for all chemicals. In addition to the secondary containment, the building was constructed as a concrete basin to provide approximately 50,000 gallons of containment. All chemical totes and drums at the treatment building will be stored on movable plastic containment pallets which provide full secondary containment as added protection within the containment confines of the building.

3.2 Pilot Unit Preparation

The Pilot Study system location is shown in Figure 3-1. Simplot provides necessary road maintenance to and within this area throughout the year. Simplot will install pumps and piping to convey the additional volume of influent water required for the Phase 2 Pilot Study. The Phase 2 expansion of the Pilot Study system will include extending the treatment building 45 feet to the north, and addition of the previously described UF, RO, FBR, post-treatment systems.

The Phase 2 Pilot Study system will be fed by waters originating from both Hoopes Spring and South Fork Sage Creek Springs. The water will be collected and conveyed by gravity to the respective pump stations, where it will be pumped to the influent wetwell of the pilot treatment facility.

3.3 Pilot Unit Operation

Water will be conveyed to the water treatment plant at a rate of approximately 2,100 gpm. A 30-day commissioning period is planned to commence with loop tests of all systems using spring water, prior to full treatment. Following commissioning, the biological reactors will be seeded and nutrient addition and chemical feed rate balancing will commence.

During operation, a carbon source (Micro C 4400 or SeHawk Nutrient), micronutrients, ammonium sulfate, and phosphoric acid will be added to the RO concentrate water prior to being delivered to the FBRs. The initial nutrient dosage has been determined based on the small-scale pilot conducted in 2015 (Stantec and RSCI 2016). Initial dose rates for other chemicals are based on the results of the Phase 1 Pilot Study. A summary of expected chemical dosage and volume present is provided in Table 3-7.

Table 3-7: Chemical Usage, Concentrations, and Storage

Processes	Chemicals	Use	Frequency of Use	Specification	Concentration	Usage	
						Daily/Skid	Annual
Ultra Filtration	NaOCl	Maintenance	Weekly	13%	300 mg/L	0.75 gpd, 1.74 gal/skid/event	272 gal
	Sodium Bisulfite	Maintenance Chemical Neutralization	Weekly	40%	419 mg/L	0.29 gpd, 0.67 gal/event	104 gal
	Citric Acid	CIP	Every 2 Months	50%	5,000 mg/L	2.1 gal/CIP/skid	38 gal
	HCl	CIP	Every 2 Months	38%	250 mg/L	3.12 gal/CIP/skid	56 gal
	NaOCl	CIP	Every 2 Months	13%	3,000 mg/L	26.5 gal/CIP/skid	477 gal
	NaOH	CIP Waste	Every 2 Months	50%	1,265 mg/L	2.15 gal/CIP/skid	39 gal
	Sodium Bisulfite	CIP Waste	Every 2 Months	40%	4,191 mg/L	10.16 gal/CIP/skid	183 gal
Reverse Osmosis	Avista Vitec 5100	Pre-Treatment	Continuous	9.15 lbs/gal	2.5 mg/L	6.55 gpd, 197 gal/month	2,391 gal
	Sodium Bisulfite	Pre-Treatment	As Needed for Cl ₂ Removal	4.44 lbs/gal	--	<1 gpd, <2 gal/month	<10 gal
	Avista ROClean P303	CIP, Low pH	Every 3 Months	8.76 lbs/gal	0.17 lbs/gal	20 gal/CIP/skid	240 gal
	Avista L111	CIP, High pH	Every 3 Months	8.76 lbs/gal	0.18 lbs/gal	21.2 gal/CIP/skid	254 gal
	HCl	CIP, As Needed	Every 3 Months If Needed	3.77 lbs/gal	As Needed	As Needed	As Needed
	NaOH	CIP Waste	Every 3 Months If Needed	6.34 lbs/gal	As Needed	4.2 gal/CIP/skid	51 gal
	HCl	CIP Waste	Every 3 Months If Needed	3.77 lbs/gal	As Needed	2.2 gal/CIP/skid	26 gal
Fluidized Bed Bioreactors	Phosphoric Acid	FBR Bioreactor	Daily	--	--	0.7 gal	243 gal
	Ammonium Sulfate	FBR Bioreactor	Daily	40%	--	8.5 gal/skid	5,500 gal
	Micro C or Frontier Water SeHawk Nutrient	FBR Bioreactor	Daily	--	--	40 gpd/train	29,200 gal
	Micro Nutrient	FBR Bioreactor	Daily	--	--	3 gpd	1,095 gal

Processes	Chemicals	Use	Frequency of Use	Specification	Concentration	Usage	
						Daily/Skid	Annual
Other	NaOH	RO Permeate pH Adjustment	Daily	6.34 lbs/gal	As Needed	<1 gpd, <2 gal/month	<10 gal
	Polymer	Settling Aid	Daily	--	--	0.5 gpd	182 gal
	Alum or Ferric Chloride	Phosphorus Removal and Settling Aid	Daily	--	--	3 to 5 gpd	1,095 to 1,825 gal

Chemical	Annual Usages (gal)	Storage
NaOCl	749	Tote
Sodium Bisulfite	297	Tote
HCl	82	Drum
Citric Acid	38	Drum
NaOH	90	Drum
Avista Vitec 5100	2,391	Tote
Avista P303	240	Tote
Avista L111	254	Tote
Alum or Ferric Chloride	1,825	Tote
Micro C or Frontier Water SeHawk Nutrient	29,200	Storage Tank
Micro Nutrient	1,095	Tote
Polymer	1,460	Drum
Phosphoric Acid	243	Drum
Ammonium Sulfate	5,500	Tote

Notes:

Source of information: Sheet G015, Chemical Use and Storage Schedules. Hoopes Treatability Pilot Phase II, Stantec 2016.

CIP = Clean In Place
gpd = gallon per day
gal = gallon
lbs = pounds
RO = Reverse Osmosis
mg/L = milligram per liter

Drum Volume = 55 gallons
Tote Volume = 275 gallons

Nutrient dosage will be optimized during system operation based on oxidation-reduction potential (ORP), pH, and dissolved oxygen (DO) measurements. The dosage and nutrient feed rate will be adjusted as necessary to maintain ORP in the range of -200 mV to -500 mV for optimum selenium reduction. In the event of a nutrient-feed-system malfunction, the system alarm set points will shut down the system and warn the operator. Monitoring of the system will be performed via radio telemetry to the mine operations building. Visual alarms will be provided on the Supervisory Control and Data Acquisition screens within both the treatment plant and at the monitoring locations at the mine operations building. The system will be configured to terminate all pumping in the event of an alarm condition and, following investigation of the alarm issues, manual restart of the treatment system will be required.

Influent water will be monitored for flow, pressure, temperature, pH, ORP, turbidity, and DO. The UF and RO skids will be monitored for pressure, turbidity, and flow. The FBR effluent will be monitored for pH, ORP, and DO. The system effluent will be monitored for temperature, pH, ORP, and DO. Pump run status indicators will monitor system hydraulic function and accurate nutrient and chemical dosing.

As described in Section 3.1, the UF and RO skids will be periodically cleaned in place. The chemical waste from the CIP processes will be stored in the CIP Chemical Waste Storage Tank for off-site disposal. The CIP rinse will be stored in the Neutralized CIP Rinse Waste Tanks and will be metered to the aeration tanks. The UF backwash will be stored in the UF Backwash Waste Tank and will be metered into the Effluent Blend Tank for eventual discharge to the creek.

The FBRs will generate biomass while reducing influent selenium and filtering the reduced particulate selenium, and will require backwashing to the backwash clarifier. Settled sludge in the backwash clarifier will be periodically transferred to the sludge storage tank. The sludge storage tank is sized at 50,000 gallons. The sludge storage tank has been sized to contain approximately 60 days of capacity in order to reduce the need to empty during the winter months. Sludge characteristics and management procedures will be evaluated and optimized during the Pilot Study. Dewatering of the sludge may be required to reduce hauling costs and for Resource Conservation and Recovery Act (RCRA) Subtitle D landfill disposal.

3.3.1 Pilot Unit Optimization

Optimization of the Pilot Unit to reach efficient removal conditions involves adjusting:

- Feed flow to determine best hydraulic retention time;
- Chemical dosing rates to minimize scale build-up in the RO skids;

- CIP chemical selection and concentrations to minimize the volume of waste produced during maintenance;
- Nutrient feed rates to optimize removal of dissolved selenium while minimizing sulfide production in the FBR trains;
- Nutrient blends to identify the most cost-effective alternatives;
- Activated sludge recycle rates and solids retention time to minimize nutrient addition while remaining within effluent concentration limits;
- Flush/chemical dosing rates to provide optimum polishing and sludge removal processes; and
- Sludge dewatering approaches to determine the most cost-effective method of sludge management and disposal.

Flow adjustment, chemical selection and dose rates, system-optimization monitoring, and maintenance operations will continue throughout the duration of the Pilot Study. Material Safety Data sheets will be provided to the Agencies in advance of any new chemicals to be introduced to the process flow stream. Flexibility in chemical selection is necessary to expedite the optimization process of the UF, RO, FBR, and post-treatment systems.

3.3.2 Pilot Unit Monitoring

Monitoring of water streams in the Pilot Study will include continuous monitoring of flow, pressure, temperature, pH, ORP, and DO using in-line measurement probes. These data will provide the information needed to optimize the operation and performance of the treatment system.

In addition, environmental monitoring involving sample collection and analysis will occur as described in Table 3-8. Samples may also be collected more frequently, as necessary, to characterize changes in performance due to system adjustments. The analyses and methods for the full analytical suite and the focused analytical suite are shown in Table 3-9 and Table 3-10, respectively.

Environmental monitoring, which is covered under this Work Plan/SAP, involves collecting samples for chemical analysis by an off-site laboratory and documenting readings from in-line probes for field parameters including temperature, pH, ORP, DO, and others. Operational monitoring is implemented by the operator to track the effectiveness of all treatment system unit processes, and to provide data for adjusting and fine-tuning the system as the study progresses. The specific parameters which are monitored and frequency of operational monitoring depend upon the unit process. Parameters and frequencies for operational monitoring will change with time based on what is learned during the study.

Table 3-8: Pilot Study Monitoring, Sampling, and Analysis Schedule

Week (System Status)	Sampling Frequency	Sampling Locations	Analyses to be Performed ^a
Week 0 ^b (Initial Steady State Flow After Start Up)	One-time	Influent, Effluent Blend Tank, UF Backwash UF permeate flow to RO skids; RO permeate flow to blending tank; RO concentrate flow to the FBRs; Bioreactor Effluent from FBR #1; Bioreactor Effluent from FBR #2; Sand filter #1 effluent; Sand filter #2 effluent	Full analytical suite ^c
Week 1 ^b (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Full suite ^c
Week 2 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Focused suite ^d
Week 3 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Full suite ^c
Week 4 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Focused suite ^d
Week 5 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Full suite ^c
Week 6 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Focused suite ^d
Week 7 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Full suite ^c
Week 8 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Focused suite ^d
Week 9 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Full suite ^c
Week 10 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Focused suite ^d
Week 11 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Full suite ^c
Week 12 (Operational)	Weekly	Influent, Effluent Blend Tank, UF Backwash	Focused suite ^d
Review and statistically evaluate the results from Weeks 0-12. Simplot and the Agencies will discuss refinement of the interim water quality target parameters. With justification, some of the parameters in the full analytical suite may be eliminated based on the results from Weeks 0-12 ^e . Furthermore, upon receipt of results from Weeks 0-12, Simplot will calculate expected water quality concentrations at key locations downstream of the treatment facility for discussion with the Agencies.			
Week 14 and every other week thereafter (Operational)	Bi-weekly	Influent, Effluent Blend Tank, UF Backwash	Focused suite ^d
Once per quarter (quarterly sample also meets requirement for bi-weekly sample)	Quarterly	Influent, Effluent Blend Tank, UF Backwash	Full suite ^c
Operational – Immediately Prior to Shut Down	One-time	Same as Week 0 locations	Full suite ^c

Notes:

^a All lab turnaround times are “standard” (2 to 3 weeks).

^b “Week 0” is the period immediately after start up, “Week 1” is approximately one week after startup, etc.

^c Refer to Table 3-9 for list of analyses and methods; some parameters may be eliminated from the full analytical suite after Week 12, based on review of results. Any refinements/reductions to the full analytical suite will be implemented after approval by the Agencies.

^d Refer to Table 3-10 for list of analyses and methods.

^e Note that the evaluation will be available 4 to 6 weeks after sample collection to allow for the standard lab turnaround time of 2 to 3 weeks and subsequent evaluation.

Table 3-9: Laboratory Analyses – Full Analytical Suite

Laboratory Analyses	Method	Reporting Limit (RL) ¹ (mg/L)
Alkalinity, as CaCO ₃	SM 2320B	1
Aluminum, total and dissolved	EPA 6010C	0.1
Ammonia as N	SM 4500 NH ₃ G	0.03
Antimony, total and dissolved	EPA 6020A	0.003
Arsenic, total and dissolved	EPA 6020A	0.003
Barium, total and dissolved	EPA 6020A	0.001
Beryllium, total and dissolved	EPA 6020A	0.0002
Biochemical Oxygen Demand	EPA 405.1	2
Boron, total and dissolved	EPA 6020A	0.05
Cadmium, total and dissolved	EPA 6020A	0.0002
Calcium, dissolved	EPA 6010C	0.05
Chemical Oxygen Demand	EPA 410.4	5
Chloride	EPA 300.0	0.2
Chromium, total and dissolved	EPA 6020A	0.0015
Cobalt, total and dissolved	EPA 6020A	0.001
Copper, total and dissolved	EPA 6020A	0.001
Fluoride	EPA 300.0	0.1
Hardness	SM 2340B (by calculation)	0.1
Iron, total and dissolved	EPA 6010C	0.06
Lead, total and dissolved	EPA 6020A	0.003
Magnesium, dissolved	EPA 6010C	0.10
Manganese, total and dissolved	EPA 6020A	0.001
Mercury, total and dissolved	EPA 7470A	0.0002
Molybdenum, total and dissolved	EPA 6020A	0.001
Nickel, total and dissolved	EPA 6020A	0.001
Nitrate+Nitrite as N	EPA 353.2 or EPA 300.0	0.05
Nitrate, as N	EPA 300.0	0.05
Total Phosphorus	SM 4500 PE	0.01
Potassium, dissolved	EPA 6010C	0.5
Selenium, total and dissolved	EPA 6020A	0.003
Selenate and selenite, dissolved ²	HPLC-ICP-CRC-MS	0.003 and 0.003
Silver, total and dissolved	EPA 6020A	0.0001
Sodium, dissolved	EPA 6010C	0.5
Sulfate	EPA 300.0	1.0
Total Sulfide	SM 4500-S-F	1
Thallium, total and dissolved	EPA 6020A	0.001
Total Dissolved Solids (TDS)	SM 2540C	10
Total Organic Carbon (TOC)	SM 5310B	1
Total Suspended Solids (TSS)	SM 2540D	5
Uranium, total and dissolved	EPA 6020A	0.001
Vanadium, total and dissolved	EPA 6020A	0.0015
Zinc, total and dissolved	EPA 6020A	0.005

¹ Each laboratory's method detection limits (MDLs) and RLs may change over time.

² Selenium species may be analyzed by a separate laboratory and at a different frequency than the other analytes.

Table 3-10: Laboratory Analyses – Focused Analytical Suite

Laboratory Analyses	Method	Reporting Limits (RL) ¹ (mg/L)
Ammonia as N	SM 4500 NH3 G	0.03
Biochemical Oxygen Demand	EPA 405.1	2
Nitrate, as N	EPA 300.0	0.05
Selenium, dissolved	EPA 6020A	0.003
Selenium, total	EPA 6020A	0.003
Total Phosphorus	SM 4500-P-E	0.01
Total Sulfide	SM 4500-S-F	1
Total Suspended Solids (TSS)	SM 2540D	5

Notes:

¹ Each laboratory's method detection limits (MDLs) and RLs may change over time.

In order to accurately represent parameters while the system is operating, environmental monitoring sample collection activities will be conducted when the system is running under stable operating conditions. In addition, samples may be collected during unstable conditions for optimization/troubleshooting. The full analytical suite (Table 3-9) for the Phase 2 Pilot Study includes all of the RI COPCs and other parameters utilized in the full analytical suite of the Phase 1 Pilot Study. The focused analytical suite (Table 3-10) will provide data for tracking selenium, ammonia, BOD, nitrate, total phosphorus, total sulfide, and TSS concentrations over time. Sample preservation and holding times are specified in Table 3-11.

During Weeks 0 through 12, environmental sampling will take place weekly with analyses each week alternating between the full analytical suite and the focused analytical suite (see Table 3-8). After receipt of the environmental monitoring results for Weeks 0 through 12, the data will be reviewed and conditions for eliminating specific analytes will be discussed with the Agencies. Environmental monitoring after Week 12 will take place bi-weekly and analyses will follow the focused analytical suite. In addition, environmental monitoring will include one sampling event each quarter, with analysis per the full analytical suite which may be revised based on review of Weeks 0 through 12 results.

Section 6.0 describes the sampling and analysis activities, and identifies individual laboratories performing analyses and specific turnaround times. Together, Section 6.0 of this plan and the *Smoky Canyon Mine Quality Assurance Project Plan for Environmental Monitoring Activities* (also known as the "Site-Wide QAPP") (Formation 2015a) shall serve as the main reference for field and laboratory personnel conducting this work and for validation and review of results. The Site-Wide QAPP, which is included in this Phase 2 Work Plan/SAP as Appendix E, has been accepted by the Agencies and is in use for various environmental monitoring programs at Smoky Canyon Mine.

Table 3-11: Sample Preservation and Holding Times

Analyte	Preservation and Storage ^a	Holding Time (days unless otherwise specified)
Total metals (excluding mercury), Hardness	HNO ₃ to pH < 2, Cool at 4°C ± 2°C	180
Total mercury	HNO ₃ to pH < 2, Cool at 4°C ± 2°C	28
Dissolved metals (excluding mercury)	Field filter; HNO ₃ to pH < 2, Cool at 4°C ± 2°C	180
Dissolved mercury	Field filter; HNO ₃ to pH < 2, Cool at 4°C ± 2°C	28
Ammonia, Total Phosphorus, Nitrate+Nitrite (EPA Method 353.2), COD	H ₂ SO ₄ to pH < 2, Cool at 4°C ± 2°C	28
TOC	H ₂ SO ₄ or HCl to pH < 2 (amber glass vial), Cool at 4°C ± 2°C	28
BOD	Cool at 4°C ± 2°C	2
Chloride, Fluoride, Sulfate, Nitrate+Nitrite (EPA Method 300.0)	Cool at 4°C ± 2°C	28
Alkalinity	Cool at 4°C ± 2°C	14
TDS, TSS	Cool at 4°C ± 2°C	7
Nitrate, as N (EPA Method 300.0)	Cool at 4°C ± 2°C	2
Total sulfide	NaOH w/Zinc Acetate, Cool at 4°C ± 2°C	7
Dissolved selenite, selenate	Field filter; Cool at 4°C ± 2°C	2 or as soon as practical

Notes:

^a Sufficient ice shall be included in the shipping containers to ensure that samples arrive at the laboratory within the appropriate temperature range.

3.4 Investigation-Derived Waste Management and Demobilization

The investigation-derived waste (IDW) generated by the Pilot Study will be:

- 1) The substrate from the fluidized bed stage;
- 2) The used filter media;
- 3) CIP chemical waste;
- 4) Dewatered sludge from the activated sludge system; and
- 5) The dewatered backwash sludge from the FBR.

These materials will be sampled and analyzed using toxicity characteristic leaching procedure (TCLP) consistent with the procedures described in Section 6.2.3. Simplot will be responsible for disposal of IDW during the study.

Additional IDW may include disposable sampling equipment, personal protective equipment, decontamination water, and spent calibration solution. All disposable sampling materials and

personal protective equipment, such as disposable spoons, gloves, and other items used in sample processing, will be disposed as regular municipal solid waste at a Subtitle D Landfill.

3.5 Proposed Schedule and Schedule Considerations

The working schedule for construction/startup of the system is:

- May 2017 – System substantially complete and ready for system commissioning; and
- July 2017 – System operational.

4.0 DATA QUALITY OBJECTIVES

The following sub-sections describe the types and quality of environmental monitoring data needed to support the evaluation of the treatment system's implementability and effectiveness, consistent with USEPA's *Guidance for Conducting Treatability Studies under CERCLA* (USEPA 1992).

4.1 Problem and Decision Statements

Problem Statement - Levels of selenium in the surface waters at the Site exceed the surface water quality standard of 0.005 mg/L, and selenium concentrations in certain springs at the South Fork Sage Creek Springs and Hoopes Spring complexes are in the range of 0.08 to 0.13 mg/L. Biological treatment has been shown to effectively remove selenium from Site water, but UF/RO and FBR and associated secondary treatment steps have not been tested. A field-scale study is needed to evaluate whether the UF, RO, and FBR technologies are feasible to implement at the Site for treatment of water discharging at the springs and to determine whether it can effectively remove selenium from Site waters while producing manageable effluent and process-waste streams.

Decision Statement - Can the UF, RO, and FBR technologies effectively remove selenium, and other COPCs, from Site waters while producing manageable effluent and process-waste streams?

4.2 Inputs to the Decision and Decision Rules

In order to evaluate whether this treatment system can effectively remove COPCs from the Site waters, water from relatively-high selenium concentrations springs at South Fork Sage Creek and from Hoopes Spring will be tested. The following decision inputs are needed and decision rules apply.

Decision Input (1) - Are the COPC concentrations in the treatment system effluent less than the COPC concentrations in the untreated influent?

Decision Rule (1) - If an overall decrease in selenium concentrations is measured in the treated effluent relative to the untreated influent, then the system is capable of removing selenium from water discharging at South Fork Sage Creek Springs and Hoopes Spring and likely capable of treating other Site waters.

Decision Input (2) – Are the selenium concentrations in the treatment system effluent less than the Idaho surface water quality standard of 0.005 mg/L?

Decision Rule (2) – If the selenium concentrations in treated effluent are greater than the standards, then the treatment system is not effective in achieving Idaho's regulatory standard for selenium in surface water when treating water from the springs.

Decision Input (3) – Are the physical and chemical characteristics of the treated effluent water suitable to allow effluent discharge to streams that support aquatic life?

Decision Rule (3) – Effluent water samples will be analyzed for the water-quality parameters listed in Table 3-9 and Table 3-10, per the sampling and analysis schedule. Effluent concentrations will be compared to the water quality standards or benchmarks shown in Table 4-1. If effluent concentrations are below water quality standards or benchmarks, then the effluent is suitable to be discharged to streams that support aquatic life.

Decision Input (4) - What are the characteristics of process-waste streams?

Decision Rule (4) – Samples of sludge, bioreactor substrate and used filter media will be collected and analyzed for hazardous waste characterization. Samples will be analyzed for metals, and results compared to maximum concentration of contaminants for toxicity characteristic criteria. If results exceed these regulatory limits, then the waste would be disposed as hazardous.

4.3 Null Hypotheses and Limits on Decision Errors

The first null hypothesis for this study is that the UF, RO, and FBR technologies cannot effectively remove COPCs from affected Site waters. The alternative is that these technologies do reduce the COPC concentrations.

Table 4-1: Benchmarks for Surface Water

Water Quality Parameter			USEPA National Recommended Water Quality Criteria ¹		Idaho Surface Water Quality Standards ²		Alternative Chronic Values			Surface Water Benchmark
			Freshwater CCC (Chronic) Criteria		Aquatic Life CCC (Chronic) Criteria					Hardness = 100 mg/L
CAS No.	Analyte	Units	Value	Notes	Value	Notes	Value	Notes	Source	
7429-90-5	Aluminum	mg/L	0.087	b	---	---	1.37	c	⁶ Parametrix 2009	1.37
7440-36-0	Antimony	mg/L	---	---	---	---	1.60	b	³ USPEPA 1986	1.60
7440-38-2	Arsenic, Dissolved	mg/L	0.15	a	0.15	a	---	---	---	0.15
7440-39-3	Barium	mg/L	---	---	---	---	0.44	b, c	⁴ MDEQ 2016 - FCV	0.44
7440-41-7	Beryllium	mg/L	---	---	---	---	0.007	b, c	⁴ MDEQ 2016 - FCV	0.007
7440-42-8	Boron	mg/L	---	---	---	---	7.2	b	⁴ MDEQ 2016 - FCV	7.2
7440-43-9	Cadmium, Dissolved	mg/L	0.0007	a, 9	0.00057	a	---	---	---	0.00057
184-540-299	Chromium VI, Dissolved	mg/L	0.011	---	0.011		---	---	---	0.011
160-658-31	Chromium III, Dissolved	mg/L	0.074	a	0.074	a	---	---	---	0.074
7440-48-4	Cobalt	mg/L	---	---	---	---	0.10	b	⁴ MDEQ 2016 - FCV	0.10
7440-50-8	Copper, Dissolved	mg/L	BLM	d	0.011	a	---	---	---	0.011
7439-89-6	Iron	mg/L	1	b	---	---	---	---	³ USPEPA 1986	1
7439-92-1	Lead, Dissolved	mg/L	0.0025	a	0.0025	a	---	---	---	0.0025
7439-96-5	Manganese, Dissolved	mg/L	---	---	---	---	1.65	c	⁵ CDPHE 2009	1.65
7439-97-6	Mercury, Dissolved	mg/L	0.00077	---	---	---	---	---	---	0.00077
7439-98-7	Molybdenum	mg/L	---	---	---	---	3.20	b	⁴ MDEQ 2016 - FCV	3.20
7440-02-0	Nickel, Dissolved	mg/L	0.052	a	0.052	a	---	---	---	0.052
7782-49-2	Selenium	mg/L	0.005	b	0.005	b	---	---	---	0.005
7440-22-4	Silver, Dissolved	mg/L	0.0032	a, e	0.0034	a, e	---	---	---	0.0034
7440-28-0	Thallium	mg/L	---	---	---	---	0.0072	b	⁴ MDEQ 2016 - FCV	0.0072
7440-61-1	Uranium, Dissolved	mg/L	---	---	---	---	1.50	c	⁵ CDPHE 2009	1.50

Water Quality Parameter			USEPA National Recommended Water Quality Criteria ¹		Idaho Surface Water Quality Standards ²		Alternative Chronic Values			Surface Water Benchmark
			Freshwater CCC (Chronic) Criteria		Aquatic Life CCC (Chronic) Criteria					Hardness = 100 mg/L
CAS No.	Analyte	Units	Value	Notes	Value	Notes	Value	Notes	Source	
7440-62-2	Vanadium	mg/L	---	---	---	---	0.027	b	⁴ MDEQ 2016 - FCV	0.027
7440-66-6	Zinc, Dissolved	mg/L	0.12	a	0.12	a	---	---	---	0.12
7440-70-2	Calcium	mg/L	---	---	---	f	---	---	---	NA
7439-95-4	Magnesium	mg/L	---	---	---	f	---	---	---	NA
7440-09-7	Potassium	mg/L	---	---	---	f	---	---	---	NA
7440-23-5	Sodium	mg/L	---	---	---	f	---	---	---	NA
---	Alkalinity, as CaCO3	mg/L	---	---	---	f	---	---	---	NA
140661-28-5	Chloride	mg/L	230	3	---	f	317	n	⁷ Iowa DNR 2009	317
18785-72-3	Sulfate	mg/L	230	3	---	f	1,093	o	⁷ Iowa DNR 2009	1,093
7664-41-7	Ammonia as N	mg/L	calculate	g	calculate	g	---	---	---	calculate
---	Biochemical Oxygen Demand	mg/L	---	---	narrative	h	---	---	---	NA
---	Dissolved Oxygen	mg/L	>6	i	>6	i	---	---	---	>6
---	Nitrate + Nitrite as N	mg/L	---	---	---	---	---	---	---	NA
---	pH	NA	6.5-9	j	6.5-9	j	---	---	---	6.5-9
---	Sulfide	mg/L	2	k	---	---	---	---	---	2
---	TDS	mg/L	---	---	---	---	1,134	l	⁸ Chapman et al. 2000	1,134
---	TSS	mg/L	---	---	narrative	m	---	---	---	NA

Table 4-1 Notes

This table is updated from Table 2-9 of the Final Site-Specific Ecological Risk Assessment Report (Formation 2015b), and includes additional water quality parameters and updates to benchmarks based on updated literature and hardness-based values. While hardness is set at 100 mg/L for this table, the actual ambient hardness of the water to be evaluated will be used for calculation of the benchmark.

Only the basis upon which the benchmark is based is presented here, with data evaluated using the appropriate basis (dissolved vs. total).

When Idaho State Standards were available, they were used as the benchmark even if they were not the most conservative benchmark. Similarly, literature-based values are used for benchmarks, instead of older National Recommended Water Quality Criteria, if the values are more recent and from ecotoxicological studies.

"---" = Information not applicable or not available

CAS – Chemical Abstracts Service

"NA" = No applicable benchmark

CCC - Criterion Continuous Concentration (i.e., chronic)

mg/L - milligram per liter

^a Aquatic life criteria for these metals are expressed as a function of total hardness (mg/L as calcium carbonate), the pollutant's water effect ratio (WER) and multiplied by an appropriate dissolved conversion factor. For comparative purposes only, the values displayed in this table are shown as dissolved metal and correspond to a total hardness of one hundred (100) mg/L and a water effect ratio of one (1.0). Criteria values for other hardness may be calculated from the following: $CCC (dissolved) = \exp \{mC[\ln(hardness)]+bC\}$ (CF).

^b Criterion is expressed as total or total recoverable (unfiltered) concentration.

^c Hardness-based value calculated using 100 mg/L CaCO₃.

^d The current copper criteria are based on the Biotic Ligand model (BLM) and requires site specific data inputs to derive the criterion value.

^e Silver criteria is acute value, chronic value not available

^f No aquatic life criteria available, but considered as a component in total dissolved solids (TDS)

^g Calculated as a pH and temperature dependent value - see **Table A** (below) for values when early life stage fish are present and not present.

^h Oxygen-Demanding Materials. Surface waters of the state shall be free from oxygen-demanding materials in concentrations that would result in an anaerobic water condition. IDAPA 58.01.02

ⁱ Dissolved oxygen is a minimum value.

^j pH to fall within the applicable range to be acceptable.

^k Expressed as H₂S.

^l No observed effects level of chironomids.

^m Surface waters of the state shall be free from floating, suspended, or submerged matter of any kind in concentrations causing nuisance or objectionable conditions or that may impair designated beneficial uses. This matter does not include suspended sediment produced as a result of nonpoint source activities.

ⁿ Derived based on hardness and sulfate concentrations (assumed sulfate = 40 mg/l).

^o Derived based on hardness and chloride concentrations (assumed chloride = 100 mg/L).

Table 4-1 Criteria Sources

¹ U.S. Environmental Protection Agency (EPA). 2009a. National Recommended Water Quality Criteria (NRWQC) for Priority Pollutants. EPA Office of Water, Office of Science and Technology (4304T). Available at <http://www.epa.gov/waterscience/criteria/wqcriteria.html>. Updated December 2, 2009.

² Idaho Administrative Procedures Act (IDAPA) 58.01.02 water quality standards - IDAPA Numeric Criteria for Toxic Substances for Waters Designated for Aquatic Life, Recreation, or Domestic Water Supply Use (IDAPA 2016).

³ U.S. Environmental Protection Agency (EPA). 1986. Quality Criteria for Water 1986 ("The Gold Book"). EPA 440/5-86-001. May 1, 1986.

⁴ Michigan Department of Environmental Quality (MDEQ). 2016. Freshwater Chronic Values (FCV) from Rule 57 Water Quality Values based on Rule 323.1057 (Toxic Substances) of the Part 4. Water Quality Standards gives procedures for calculating water quality values to protect humans, wildlife and aquatic life. Updated 10/21/2016.

Table 4-1 Criteria Sources (continued)

- ⁵ Colorado Department of Public Health and Environment (CDPHE) Water Quality Control Commission (WQCC). 2007. Reg. Number 32. Classifications and Numeric Standards for the Arkansas River System, updated February 2009. Available at <http://www.cdphe.state.co.us/regulations/wqccregs/100232arkansasriverbasinnew.pdf>
- ⁶ Parametrix. 2009. Updated Freshwater Aquatic Life Criteria for Aluminum (Exhibit 2 of Direct Testimony of Robert W. Gensemer, Ph.D.). Prepared for Los Alamos National Laboratory. 25 pp.
- ⁷ Iowa DNR. 2009. Water quality standards review: Chloride, sulfate, and total dissolved solids. Iowa Department of Natural Resources, Des Moines, Iowa. http://www.iowadnr.gov/portals/idnr/uploads/water/standards/ws_review.pdf
- ⁸ Chapman, P.M., H. Bailey, and E. Canaria. 2000. Toxicity of Total Dissolved Solids Associated with Two Mine Effluents to Chironomid Larvae and Early Lifestages of Rainbow Trout. Environmental Toxicology and Chemistry: Vol. 19, No. 1, pp. 210–214.
- ⁹ USEPA. 2016. Aquatic Life Ambient Water Quality Criteria, Cadmium - 2016. EPA-820-R-16-002. <https://www.epa.gov/wqc/aquatic-life-criteria-cadmium-documents>

Table A. Chronic Criterion Calculation for Ammonia When Early Life Stage (ELS) Fish are Absent or Present

Temp (degrees C)	pH	Total Ammonia N (mg/L)	
		ELS Absent	ELS Present
9	6.5	9.51	6.67
10	6.5	8.92	6.67
11	6.5	8.36	6.67
12	6.5	7.84	6.67
13	6.5	7.35	6.67
9	7	8.43	5.91
10	7	7.91	5.91
11	7	7.41	5.91
12	7	6.95	5.91
13	7	6.52	5.91
9	7.5	6.23	4.36
10	7.5	5.84	4.36
11	7.5	5.48	4.36
12	7.5	5.13	4.36
13	7.5	4.81	4.36
9	8	3.47	2.43
10	8	3.26	2.43
11	8	3.05	2.43
12	8	2.86	2.43
13	8	2.68	2.43

There are two types of decision errors: a false rejection error (Type 1) and a false acceptance error (Type 2). A Type 1 error is determining that elevated COPC concentrations remain in the treated effluent relative to the influent, indicating ineffective treatment when, in fact, COPC concentrations have decreased. A Type 2 error is determining that COPC concentrations in the effluent are reduced relative to influent concentrations, indicating that the treatment is effective when, in fact, COPC concentrations in the effluent are not reduced relative to the influent. A Type 1 error may result in a decision not to adopt a treatment system. A Type 2 error may result in adopting inadequate treatment and continued discharge of elevated COPC concentrations.

The second null hypothesis for this study is that the UF, RO, and FBR technologies cannot achieve the surface water quality standards for COPCs in the treated water. The alternate hypothesis is that the treatment system does achieve the surface water quality standards. The Type 1 error in this case would lead to a conclusion that the treatment system does not achieve the standards when it actually does. The Type 2 error would lead to a conclusion that the treatment system does achieve the standards when it actually does not.

The third null hypothesis for this study is that the UF, RO, and FBR technologies produce changes in influent water physical and chemical properties (i.e., temperature, suspended solids/turbidity, dissolved oxygen, and major-ion content) that are not compatible with stream water that support's aquatic life. Type 1 error in this case would lead to a conclusion that the treatment system effluent is not compatible with stream water when it actually is. The Type 2 error would lead to a conclusion that the treatment system is compatible with stream water when it actually is not.

The fourth null hypothesis for this study is that the UF, RO, and FBR technologies produce process waste that would be classified as hazardous (with TCLP characteristics exceeding regulatory limits). The alternative is that the treatment system does not produce process-waste that would be classified as hazardous (with TCLP characteristics below regulatory limits). A Type 1 error is determining that the process waste would be classified as hazardous, indicating that the waste does have to be disposed as hazardous waste when, in fact, it does not. The Type 2 error would determine that the process waste would not be classified as hazardous, indicating that the waste does not have to be disposed as hazardous waste when, in fact, it does.

The number of samples collected to test the null hypotheses presented above needs to be sufficient to allow for decision making at acceptable confidence levels.

- The first hypothesis will be tested through comparison of the influent and effluent COPC concentrations. A statistical test will be performed to compare the two sets of COPC concentrations, and that test will have 95 percent confidence level for detecting differences between the two data sets. In this case the Type 1 error rate will be 5 percent.

- The second hypothesis will be tested through comparison of the mean effluent COPC concentrations to the surface water quality standards. A 95 percent confidence limit on the mean is a commonly applied basis for comparison to a regulatory standard.
- The third hypothesis will be tested through comparison of effluent water physical and chemical characteristics to water quality standards or benchmarks. These comparisons will indicate whether there are physical and chemical changes caused by treatment using the Pilot Unit that could have negative effects on aquatic life in local stream waters receiving treated effluent water.
- The fourth hypothesis will be tested through comparison of process waste TCLP test results to the regulatory criteria. Each test result will be compared directly to the regulatory criteria.

To control decision errors, only quantitative data with acceptable accuracy and precision documentation will be used for comparison to standards. Samples will be analyzed by SVL Analytical, Brooks Rand Labs LLC, and/or IAS Analytical using USEPA-approved methods with detection limits below the surface water quality standard for selenium and other COPCs. Measurement errors for all sample analyses will be minimized by implementing standard procedures for the sample collection, handling, preparation, and analysis methods, as described below in Section 6.0.

4.4 Optimizing the Sampling Design

The sampling design, strategy, and quality assurance (QA) requirements are presented in the Sampling and Analysis Plan (SAP), which is Section 6.0 of this document. Additional samples may be collected during the Pilot Study, if and as necessary, to increase the confidence of decision making in accordance with the data quality objectives (DQOs) set forth in this plan.

5.0 ROLES AND RESPONSIBILITIES

J4 Engineering has been selected as the Owner's representative and will coordinate design, bidding, and construction of the Phase 2 Pilot Study system.

Frontier is the vendor that will be providing the treatment system. Frontier is responsible for:

- Pilot system design and procurement;
- Selecting the microbial combination and nutrient blends;
- Pilot Unit start-up and training; and
- Off-site transport of the Pilot Unit.

Stantec and RSCI will be the design build engineer and contractor.

Simplot will be operating the pilot treatment system. Simplot is responsible for:

- Pilot Unit operation, performance monitoring, maintenance, shut down; and
- Performance data interpretation.

The Simplot contact for overall management, technical design, operation, and maintenance of this Pilot Study will be Jonathan Witt. The Smoky Canyon Mine Manager will assign appropriate personnel responsible for operation of this Pilot Unit and any ancillary equipment. Simplot is responsible for:

- Implementation of the project;
- Communication with the agencies;
- Connecting the Pilot Unit to power and internet services;
- Providing staff for daily on-Site operation and routine sampling of the Pilot Unit;
- Contracting a laboratory for sample analysis; and
- Disposal of the IDW, and demobilization.

Formation Environmental is the CERCLA consultant/contractor to Simplot and is responsible for integrating the Pilot Study results into an evaluation of the technology's effectiveness and implementability.

The USFS and supporting agencies will perform oversight of the Pilot Study implementation, and make determinations, approvals, or disapprovals for any action under State and Federal law.

Simplot personnel performing the day-to-day operation of the UF/RO and FBR treatment system will be trained by Frontier representatives. Simplot personnel operating the UF and RO Systems will receive training from the UF and RO vendor, Westech Inc., Salt Lake City, UT. All personnel operating the treatment system and conducting sampling activities must have appropriate health and safety training before starting work on the Site. Contractors will provide a Health and Safety Plan (HASP) for Simplot review prior to mobilizing to the Site. Simplot will provide MSHA training, as needed.

6.0 SAMPLING AND ANALYSIS PLAN

This SAP section of the Phase 2 Work Plan/SAP provides details of the procedures for environmental sampling and data collection during the Pilot Study. Included in this section are project-specific QA and Quality Control (QC) requirements. Additional QA/QC procedures and specifications are provided by the Site-Wide QAPP (Formation 2015a), which serves as a companion document with this plan to guide the sampling and analysis activities associated with the water treatment system. Both this plan and the Site-Wide QAPP (Appendix E) should be referred to by the field and laboratory personnel performing the work described herein.

6.1 Routine Operations Monitoring for System Optimization

Monitoring of water streams conducted in the Pilot Study will entail documenting:

- Influent flow, pressure, temperature, pH, ORP, and COPC concentrations;
- UF vessel pressure, temperature, and influent turbidity;
- UF backwash frequency and volume;
- Anti-scalant and sodium bisulfate dose rates;
- RO pressure, temperature, pH, and influent turbidity;
- FBR effluent pH and ORP;
- Effluent temperature, pH, DO, and COPC concentrations;
- Post-treatment system solids recycle rate and solids retention time; and
- Dose rates of nutrients and other chemicals.

As previously mentioned, the Pilot System will be equipped with dedicated in-line instruments to continuously monitor flow, ORP, pH, DO, and temperature.

6.1.1 Field Equipment Testing and Calibration Procedures

Equipment needing calibration, such as the above-mentioned water-quality instruments, will be calibrated during commissioning of the Phase 2 Pilot Study and checked once a week using calibration standards to ensure that the accuracy and reproducibility of the results are consistent with the manufacturer's specifications and the project's data needs. In the event that a field instrument cannot be calibrated to meet the manufacturer's specifications, it will be serviced or replaced.

6.1.2 Field Equipment Decontamination

The sampling program minimizes potential cross-contamination of samples by utilizing clean disposable equipment to collect samples directly from the water sampling ports. Any necessary equipment decontamination will be performed as outlined in Standard Operating Procedure (SOP) No. 7 (Appendix B).

6.2 Sampling Design and Methods

In order to address the data quality objectives described in Section 4.0, water samples will be collected before, during, and after operation of the pilot treatment system. Waste samples will be collected during and at the completion of the Pilot Study. These environmental monitoring activities are described separately below.

6.2.1 Performance Monitoring Sampling Design and Methods

System performance will be monitored, under the environmental monitoring program, through routine collection and analysis of samples from the following points in the treatment process:

1. Influent;
2. UF permeate flow to RO skids;
3. RO permeate flow to blending tank;
4. RO concentrate flow to the FBRs;
5. Bioreactor Effluent from FBR #1 (existing Phase 1 FBR);
6. Bioreactor Effluent from FBR #2 (new Phase 2 FBR);
7. Sand filter #1 effluent;
8. Sand filter #2 effluent;
9. Effluent blend tank; and
10. UF backwash.

The samples will be analyzed for the environmental monitoring parameters listed in Table 3-9 and Table 3-10, as described in greater detail in the next section, to evaluate the system's overall performance in achieving specific water treatment objectives described in Section 4.0.

6.2.2 Routine Performance Evaluation Sampling

Routine environmental monitoring samples, for evaluation of system performance, will be collected every week from Weeks 1-12 after starting the treatment system (Week 0) (Table 3-8). Samples collected in Week 0 will be analyzed for the full analytical suite (Table 3-9), samples

collected in odd-numbered weeks (Weeks 1, 3, 5, etc.) will be analyzed for the full analytical suite, and samples collected in even-numbered weeks (Weeks 2, 4, 6, etc.) will be analyzed for the focused analytical suite (Table 3-10). Analyses for the full analytical suite will be performed by SVL Analytical or IAS EnviroChem, whereas analyses for the focused analytical suite will be performed by IAS EnviroChem. Analysis of samples for selenium speciation (selenate and selenite) will be performed by Brooks Rand Labs LLC or IAS Envirochem. All samples will be analyzed with a standard turnaround time. The laboratories identified above are certified for environmental work (see Appendix F).

The sampling frequency may be revised after review of results from sample collection in Weeks 0-12, based on discussions with the Agencies. Furthermore, the full analytical suite and/or focused analytical suite may be revised based on reviews of the monitoring results (see Section 3.3.2 and Table 3-8).

For samples to be analyzed for the focused analytical suite, due to the 48-hour hold time for nitrate analyses these samples will be transported via overnight courier to IAS EnviroChem in Pocatello, Idaho within 24 hours of collection.

Contracted laboratories will provide pre-cleaned sample containers and appropriate preservation reagents. Preservation and storage requirements associated with the individual analyses to be performed and the referenced analytical methods are summarized in Table 3-11.

Field parameters, including DO, pH, ORP, temperature, and flow will be measured and recorded. Additional details on collecting field measurements, including calibration and any decontamination procedures, are provided in Section 6.1 and the Site-Wide QAPP (Appendix E).

6.2.3 Waste Characterization Sampling and Analysis

The IDW generated by the treatment process will include bioreactor substrate, used filter media, and sludge. Additional IDW may include disposable sampling equipment, personal protective equipment, decontamination water, and spent calibration solution. Simplot will dispose the IDW during and at the completion of the study.

Sludge will be collected for analysis prior to initial disposal and for subsequent disposal only if the sludge is expected to vary significantly from the initial disposal. Bioreactor substrate and filter media will be analyzed if it becomes spent. Each sample will be collected as a composite comprised of five discrete grab samples each consisting of 100-200 grams of solid material (wet weight) (as per SOP No. 14, Sediment Sampling for Chemical Analyses). Each grab sample will be composited together in a single container and homogenized using procedures consistent with sediment sampling procedures described in SOP No. 14 (Appendix B). The solids/sludge

sample will be stored at approximately 4°C and shipped via overnight courier to SVL Analytical or IAS EnviroChem for analysis using TCLP for the 8 RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) to determine the proper course of disposal according to local regulations.

6.3 Sample Documentation and Handling

Sample collection activities will be documented on field forms according to methods outlined in SOP No. 1 (Appendix B).

6.3.1 Field Notes

Documentation of observations and data acquired during the Pilot Study will be recorded on field data sheets. Wherever a sample is collected or a measurement is made onsite, the sample location will be identified and any additional observations will be recorded.

Data sheet entries will, at a minimum, include the information listed below:

- Project name and number;
- Location of sample;
- Date and time of sample collection;
- Sample identification numbers;
- Description of sample (sample matrix or species);
- Number of samples collected;
- Field measurements;
- Field observations and weather conditions;
- Personnel present; and
- Sampler's signature.

Changes or deletions on the data sheets will be recorded with a single strike mark through the changed entry, with the sampler's initials and the date recording the new entry. All entries must remain legible. Sufficient information should be recorded to allow the Pilot Study sampling event to be reconstructed without having to rely on the sampler's memory. Additional instructions on field documentation procedures can be found in SOP No. 1 (Appendix B).

6.3.2 Sample Identification and Labeling

Samples will be assigned unique sample identification numbers. These numbers are required for tracking the handling, analysis, and reporting status of all samples collected during monitoring. Each sample identification number will identify the sampling location and type of sample. Sample identification numbers will be assigned using several codes as follows.

The first field in the identification number identifies the Site and general time period. For example, samples collected during the Smoky Canyon Mine Pilot Study in July 2017 will all have the prefix "SC[07][17]".

The second field in the identification number identifies the location of the sample. For this Pilot Study, this second field will be "LSSHS". The third field identifies the sample matrix type, a digit for describing the intended sample use, and the sample number. The matrix types are defined as:

- IN: Influent;
- UFP: UF permeate flow to RO skids;
- ROP: RO permeate flow to blending tank;
- ROC: RO concentrate flow to the FBRs;
- BE1: Bioreactor Effluent from FBR #1 (existing Phase 1 FBR);
- BE2: Bioreactor Effluent from FBR #2 (new Phase 2 FBR);
- SE1: Sand filter #1 effluent;
- SE2: Sand filter #2 effluent;
- EF: Effluent blend tank; and
- UFB: UF backwash.

The sample use digits are defined as:

- 0 – Primary sample;
- 2 – Field duplicate sample; and
- 3 – Equipment rinsate sample.

Note that additional codes may be added as the project proceeds. The additions will be communicated immediately to the field staff, data management team, and project chemist.

The final two digits are unique sample numbers per event. Numbers will begin with 01 and increase consecutively for the number of samples in an event (typically a month). The numbering is reset for the following event.

For example:

- SC0817-LSSHS-IN003, is a primary water sample collected from the influent in August 2017 with the sequential number 3; and
- SC0917-LSSHS-ROC202, is a field duplicate water sample collected from the RO concentrate flow in September 2017 with the sequential number 2.

Each sample that is collected in the field will be labeled for future identification. Sample labels will be pre-printed with as much information as possible. Additional information will be filled out using waterproof ink. At a minimum, each label will contain the following information:

- Site location;
- Sample identification number;
- Date and time of sample collection; and
- Analyses required.

Site-specific samples to be used for the matrix spike/matrix spike duplicates will be identified on the labels and chain-of-custody forms.

6.3.3 Sample Handling and Shipping

After collection, samples to be shipped will be packed in an insulated cooler with bags of ice. Packing material may be used to prevent breakage during shipment. A labeled temperature blank may also be included with each cooler shipped, if the laboratory does not possess infrared temperature sensors. Ice placed in the cooler will be double-bagged to prevent leakage of water. The coolers will be taped shut and custody seals attached.

All samples will be transferred or shipped for laboratory receipt and analysis within the holding times specified in Table 3-11.

6.3.4 Sample Custody

After samples have been collected, they will be maintained under strict chain-of-custody (COC) protocols, in accordance with specifications included in the Site-Wide QAPP (Appendix E). The field sampling personnel will initiate and complete a COC form for each shipping container (i.e., cooler, ice chest or other container) of samples, or set of shipping containers for a given sampling event, to be delivered to the laboratory for analysis. The COC for a shipping container, or set of shipping containers, will list only those samples in the shipping container(s). Information contained on the COC form will include the following:

- Project number;
- Date and time of collection;

- Sample identification number;
- Sample matrix;
- Analyses requested;
- Number of containers for each sample;
- Sample preservation;
- Sampler's signature and affiliation;
- Signature of persons relinquishing custody, dates, and times;
- Signature of persons accepting custody, dates, and times;
- Method of shipment;
- Shipping air bill number (if the samples are shipped);
- Condition of samples and cooler temperature upon receipt by laboratory; and
- Any additional instructions to the laboratory.

6.4 Data Quality Indicators

The Data Quality Indicators (DQIs) for data collected in support of the Pilot Study are accuracy, precision, completeness, representativeness, and comparability. The DQI control limits and acceptance criteria for data collected during the Pilot Study are provided in the Site-Wide QAPP (Appendix E), by laboratory analytical method, in the series of tables presenting summaries of calibration and QC procedures.

6.5 Quality Assurance and Quality Control

The Site-Wide QAPP (Formation 2015a), provided as Appendix E, presents QA/QC policies and procedures developed to ensure that the data collected in the field and analyzed by the laboratory are of appropriate quality to meet project objectives. Certain deviations from the procedures specified by the Site-Wide QAPP are appropriate for data intended to evaluate the performance of the treatment system. These deviations are identified and explained below.

6.5.1 Field Quality Control Samples

The field QC practices will consist of the collection of QC samples, decontamination of field sampling equipment, and adherence to SOPs. Specifications in the Site-Wide QAPP (Appendix E) will be followed with an addition of filter blank samples for field QC.

A filter blank sample consists of two bottles. One bottle is analyte-free, reagent-grade water pumped through unused, clean tubing and filtered into an unused, clean sample container at the

field sampling location and preserved as needed. The second bottle is analyte-free, reagent-grade water collected in an unused, clean sample container at the same field sampling location as the first bottle and preserved as needed. Filter blank bottles are analyzed as regular field samples. The filtered and unfiltered bottles are analyzed for the same complete list of dissolved and total target analytes as the associated samples (Table 3-9 and Table 3-10). Analyses of filter blanks quantify any artifacts introduced into the sample due to the filter tubing and/or filter.

Filter blanks will be collected at a rate of 1 per filter lot.

6.5.2 Laboratory Quality Control Samples

The laboratory QC practices will follow specifications presented in the Site-Wide QAPP (Appendix E). Laboratory QC will ensure that laboratory analyses are sufficiently sensitive, accurate, and precise to meet the objectives of the sampling. The commercial laboratories used will perform the requested analyses in accordance with referenced USEPA methods (when available) and will operate under an internal QA Management Plan.

6.6 Data Reporting and Management

The analytical laboratories will provide preliminary data to the following recipients:

Jonathan Witt, J.R. Simplot Company, Project Technical Manager
(jonathan.witt@simplot.com) – electronic data deliverables (EDDs)

Art Burbank, USFS, (alburbank@fs.fed.us) – EDDs

Karen Schneider, Formation (kschneider@formationenv.com) – hard copy and EDDs

Deliverables will be sent to the USFS at the same time as they are sent to other recipients.

Laboratory data packages and available field documentation will be filed, and the electronic data will be stored in a computer database maintained by Formation. Final entry of the information into the database will not be completed until the data review or validation is completed, and it is determined that the data reported from the field and laboratory are complete. Further details on data management are included in the Site-Wide QAPP (Appendix E).

7.0 DATA REVIEW AND REPORTING

The environmental monitoring data collected as part of this Pilot Study will be evaluated to determine if the DQOs are met and to evaluate and report the performance and effectiveness of the treatment system.

7.1 Data Evaluation

Laboratory reports will document sample custody, analytical results and QA/QC, adherence to prescribed protocols, nonconformity events, corrective measures, and/or data deficiencies. Laboratory data reporting requirements are specified in the Site-Wide QAPP (Appendix E).

The laboratory data will be reviewed and evaluated for accuracy and precision to ensure that the data are of sufficient quality to assess the treatment's performance. The review will confirm that all requested analyses were performed using the procedures specified in the Site-Wide QAPP (Appendix E). Any deviations from the work plan or concerns regarding data quality will be resolved by working with the laboratory, which may include request for reanalysis of samples.

Field measurements will also be reviewed before those data are reported. The field notes, measurement entries, and any calculations will be subject to a peer review. Errors identified during the review will be corrected by the field staff with documentation of the correction date.

7.2 Data Validation

Data validation will be performed by a third party using the general protocols and processes described in the Site-Wide QAPP (Appendix E).

7.3 Reporting

Unless otherwise specified, Simplot will provide monthly progress reports from the approval of this work plan until completion of the Pilot Study.

During the design phase, the reports will describe progress made in design, contractor and equipment procurement and construction, along with an anticipated start-up date, once known.

Weekly email updates on the Pilot Study construction and implementation will be provided to the Forest Service Remedial Project Manager in the form of an email every Friday, or as soon as possible early the next week. The weekly updates will include descriptions of the past week's

activities, and the upcoming week's planned activities. Once the system has been running for several weeks and is in steady-state operational mode, the Forest Service and Simplot can determine the need to continue the weekly updates and/or change the frequency of said updates.

During the study implementation, reports will include a description of activities completed in the preceding month and the activities planned for the subsequent six weeks. Field and laboratory data available at the time of each progress report will also be included.

Within 90 days after completion of the Pilot Study, Simplot will prepare a Treatability/Pilot Study Report documenting the findings of the study. Following the Agencies' review of the report, Simplot will address comments and prepare and submit a final Treatability/Pilot Study Report.

8.0 REFERENCES

- Formation, 2011. Reverse Osmosis Treatment Technology Pilot Study Report - Hoopes Spring. Smoky Canyon Mine. Prepared for the J.R. Simplot Company. December 2011.
- Formation, 2012. Pilot Study Report. Zero-Valent Iron Treatment Technology – South Fork Sage Creek Springs. Smoky Canyon Mine. Prepared for J.R. Simplot Company. July.
- Formation, 2014a. Final Smoky Canyon Mine Remedial Investigation Report. Smoky Canyon Mine. Prepared for the J.R. Simplot Company. September.
- Formation, 2014b. Surface Water Treatability Study Technical Memorandum Addendum. Smoky Canyon Mine. Prepared for the J.R. Simplot Company. May.
- Formation, 2014c. Final Pilot Study Work Plan and Sampling and Analysis Plan, (Phase 1) Biological Selenium Removal Treatment Technology Fluidized Bed Bioreactor, and subsequent Addenda 01 through 04. Smoky Canyon Mine. Prepared for the J.R. Simplot Company. September.
- Formation, 2015a. Smoky Canyon Mine Quality Assurance Project Plan for Environmental Monitoring Activities (Appendix B of the Comprehensive Environmental Monitoring Program Plan [CEMPP], Draft Revision No. 4). Smoky Canyon Mine. Prepared for the J.R. Simplot Company. August.
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- Formation, 2016. Draft Feasibility Study Technical Memorandum #1: Development and Screening of Remedial Alternatives. Smoky Canyon Mine. May.
- Idaho Department of Environmental Quality (IDEQ), 2006. Idaho Administrative Procedures Act (IDAPA) 58.01.02.210. Numeric Criteria For Toxic Substances For Waters Designated For Aquatic Life, Recreation, or Domestic Supply Use.
- Mayo, A.L., A.B. Muller, and D.R. Ralston, 1985. Hydrogeochemistry of the Meade Thrust Allochthon, Southeast Idaho and its Relevance to Stratigraphic and Structural Groundwater Flow Control. Journal of Hydrology, Vol. 76, p. 27-61.
- Simplot, 2014. Letter from Mr. Alan Prouty, J.R. Simplot Company to Ms. Nora Rasure, US Forest Service dated January 8.
- Stantec and RSCI, 2016. UF/RO Pilot Testing Report, Smoky Canyon Selenium Pilot Treatment System, Phase II Expansion, Project No. HS-0002. January 28.
- USEPA, 1992. Guidance for Conducting Treatability Studies under CERCLA. (<http://www.epa.gov/superfund/policy/remedy/pdfs/540r-92071a-s.pdf>).

APPENDIX A – electronic only

Selenium Concentration and Flow Data for

South Fork Sage Creek Springs and Hoopes Spring

APPENDIX B – electronic only

Pilot Study Work Plan and Sampling and Analysis Plan

(Phase 1) Biological Selenium Removal Treatment Technology, Fluidized Bed Bioreactor

(September 5, 2014 Final submittal, along with updates and addenda)

APPENDIX C – electronic only

Monthly Progress Reports for Phase 1 FBR Treatability Study

APPENDIX D

Summary of Results

Phase 1 Biological Selenium Removal Treatment Technology

Fluidized Bed Bioreactor

APPENDIX E – electronic only

Smoky Canyon Mine Quality Assurance Project Plan for

Environmental Monitoring Activities

**(Appendix B of the Comprehensive Environmental Monitoring Program Plan [CEMPP],
Draft Revision No. 4)**

Also Known as the Site-Wide QAPP

APPENDIX F

Laboratory Certifications for Environmental Work